






Let Unico
improve your
home's indoor
air quality

A guide to **indoor air quality**

We all know about washing hands and disinfecting surfaces, but did you know that an HVAC system is also a vital part of disease prevention? An HVAC system is designed to improve indoor air quality (IAQ). This has long been a benefit and with Covid-19 became urgent. This article is meant to aid your awareness of indoor air quality best practices.

 Prepared by:
Craig Messmer, P.E. in conjunction with
the Unico Inc. Marketing team

 Unico UK
Unit 27 Prince Road, Kings Norton Business Park, Kings
Norton, Birmingham, B30 3HB.

 Issued: August 2020

Warm in winter. Cool in summer. Always beautifully fresh, filtered air.

Your home:
 you live there,
 you may work
 there, you should
 breathe clean air
 there...

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Craig Messmer, P.E.

Vice President of
 Engineering

Craig has been with Unico for 26 years helping to grow Unico from six employees to where we are today with 100 employees.

Over the years, Craig has been involved with product development, manufacturing, customer service and sales support. He is still involved in those things today but mostly as an advisor.

His focus is to manage the engineering team, to mentor the other engineers and support staff and to be the voice of Unico for industry and regulatory issues.

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 www.unicosystem.co.uk

 01384 422 094

 info.uk@unicosystem.com

Indoor Air Quality (IAQ)

The importance of Indoor Air Quality (IAQ) has never been greater. Tight construction can trap contaminants and keep air within the home. Additionally, viruses do not easily dissipate increasing the likelihood of them spreading throughout the conditioned environment.

IAQ in the time of Covid-19

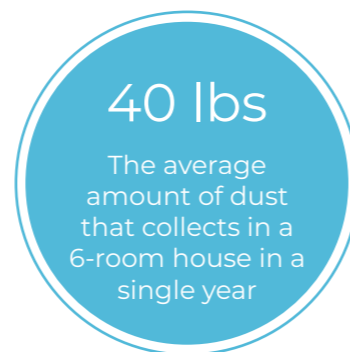
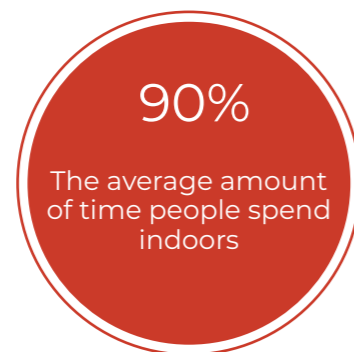
Clean indoor air is important for you and your families health

We are all faced with an unprecedented challenge of remaining safe from an invisible enemy. Spending more time at home is essential. Therefore, it is also essential to safeguard your home as much as possible. While no solution is a guarantee, there are things that can be done to mitigate the risks of transmission between family members. We all know about washing hands and disinfecting surfaces, but did you know that an HVAC system is also a vital part of disease prevention? An HVAC system is designed to improve indoor air quality (IAQ). This has long been a benefit and with Covid-19 has become urgent. This article is meant to aid your awareness of indoor air quality best practices.

Most homeowners in the UK experience indoor pollution issues

IAQ and your health

Good indoor air quality means clean air. Air devoid of dust, pollen, pathogens, odours, and harmful gases. The EPA succinctly describes it as the quality of the air in and around buildings as it relates to health and comfort¹. Having good IAQ is important to everyone but especially individuals with health concerns such as asthma, respiratory illness, compromised immune systems or thermoregulation problems. These generally affect the very young and the very old although anyone can suffer.



¹ <https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality>

Strategies to improve IAQ

There are several strategies to improve Indoor Air Quality.

Ventilation

Ventilation is the first solution to incorporate. Too much outside air coming in can impede your HVAC system and drive up energy bills. Not enough ventilation can cause indoor pollutants to build up to unhealthy levels. There is a happy medium.

Air filtration

Air filtration is essential, especially if the outside air is not very good. Air filters come in many varieties and are used for many different purposes. The higher the rating on a filter, the more particles and contaminants the filter will capture.

Temperature regulation

Temperature regulation is often overlooked as being a part of IAQ, but maintaining temperatures for a home or building is probably the most important benefit of the HVAC system. The best HVAC systems can minimize temperature fluctuations.

Odour control

Odour control is an important part of IAQ, especially for homeowners. For things such as smoke or cooking oils, they are generally captured by normal air filtration, especially using a higher rated filter.

Humidity control

Humidity control relies on the inherent dehumidification of the HVAC system that matches the moisture load of the house. If the system does not perform properly it can potentially lead to IAQ problems in the home.

Air distribution

Air distribution is what provides good temperature regulation. For a traditional HVAC system, air is pushed into the room and then drawn out of the room back to the equipment only to repeat the cycle. Unico has a better solution.

Air disinfection

Air disinfection is the process of killing pathogens and destroying viruses. There is only one known technology that can accomplish this while the occupants are in their home or building. For over 100 years, this type of disinfection has been successfully used in healthcare settings.

Virus transmission

As we learn more about virus transmission, it is increasingly important to maintain a safe distance apart, to have good air distribution, filtration, and disinfection. Thus far, there has been one study that discusses the role of the HVAC system. This study, from China, indicated that the HVAC system contributed to the Covid-19 transmission². As it turns out, the restaurant used a ductless unit with no ventilation, no air filtration, and no disinfection. Transmission would likely have been greatly diminished if any of these were included, even an open window would have helped. This, of course, emphasises the importance of a central air system and following guidelines on ventilation, filtration, and temperature control.

² https://wwwnc.cdc.gov/eid/article/26/7/20-0764_article

Ventilation

Ventilation is probably the earliest known method of improving IAQ. It is why we have windows. It is the first solution to incorporate.

However, this strategy is not effective if the outdoor air quality is worse than the indoor quality. Security is also a concern. Ventilation can bring in unwanted pollution (smoke, pollens, carbon monoxide); Ventilation could increase the heating and cooling loads and energy costs; ventilation could bring in excessive humidity.

On the other hand, if there is no ventilation at all, indoor pollutants (CO₂, etc.) will build up to unhealthy levels. Obviously, there must be a happy medium. That is where ASHRAE steps in. There are two standards that address ventilation: one for commercial buildings (ASHRAE Standard 62.1) and one for residential buildings (ASHRAE Standard 62.2). Both standards require the assistance of an industry professional to analyse your building and determine what is needed. They will consider the size of the building, how much the building leaks air, where it is located, the number of occupants, the type of use and other factors. In the UK, the European EN779:2012 standard is also used to rate filtration and ventilation efficiency.

For most existing homes, ventilation is not needed because of natural infiltration. Basically, the house leaks air. This is changing though. New or renovated homes are much tighter. And the newest homes built to low load home (LLH) standards are extremely tight. In tight homes, mechanical ventilation is a must. This can be a separate system or integrated with the HVAC system. Mechanical ventilation systems circulate fresh air using ducts and fans, rather than relying on airflow through small holes or cracks in a home's walls, roof, or windows. The ventilation system typically brings into the house a percent of the total air that the central air system circulates. This improves IAQ by diluting the indoor air with fresh "good" air

from the outside. As stated already, this can be detrimental if the outside air contains mold, pollen, and other pollutants. Viruses do not generally survive the outdoors, so dilution helps mitigate transmission from aerosolised viruses inside the building.

Integrating ventilation with your HVAC system is probably the most cost effective method to improve IAQ. It works best with central air systems. By contrast, providing ventilation is much more difficult in parts of the world that use ductless mini or multi-split systems.

The simplest method to add ventilation in a central air system is to install a return from the outside and let the HVAC blower suck fresh air into the house. The return opening should have an inlet screen for bugs and large pests. The outside air should be filtered (sometimes with a separate filter), be sized appropriately, and often a damper to modulate the amount of fresh air.

More complex ventilation systems might include an energy recovery ventilator (ERV) or a heat recovery ventilator (HRV) to save money on your heating and cooling bills. These devices wring out (recover) some of the heat from either the exhaust or the fresh air. The ERV also wrings out some of the humidity from the fresh air system. Anything that makes the HVAC heating and cooling system work less will save money. Of course, adding an ERV/HRV adds cost to the installation so consider its value based on climate, maintenance, and use.

The Unico System variable speed blower includes specific control features to incorporate ventilation. It has a built-in function to automatically turn on the blower, turn on an HRV/ERV, or open a damper. This integration is flexible in that it can be easily programmed to meet the needs of the home in compliance with ASHRAE 62.2-2010 residential ventilation standard.

Air Filtration

Even when providing outside air, most of the air in a central air system is recirculated from the indoors. Dilution does a great job of reducing some pollutants, notably gases, but doesn't do a very good job of removing larger particles. And, if the outside air is not very good, air filtration is essential.

Air filters come in many varieties and for various purposes.

There are so many types and brands, that ASHRAE in the USA and the EN779:2012 standard in Europe, created a rating system to help you select the right filter. Look for the ratings when you select a filter. The higher the rating, the smaller the particles the filter will capture. The capture of viral particles is directly related to the rating, so higher rated filters capture more particles³.

MERV 1-4	For general residential HVAC applications	MERV 5-8	For upgraded residential HVAC applications
EN779:2012 G1 & G2	Captures contaminants such as: pollen, dust mites, and small fibers.	EN779:2012 G3 & G4	Captures contaminants such as: mold spores, pet dander, and hair spray.
MERV 9-12	For superior residential HVAC, commercial HVAC, and hospital labs	MERV 13-16	For hospital or general surgery applications
EN779:2012 M5 & M6	Captures contaminants such as: legionnaire, fine dust, and large droplets.	EN779:2012 F7, F8, F9	Captures contaminants such as: bacteria, small droplets (sneeze), smoke particulate, and fine powders.

The least efficient filters are designed to keep the HVAC system clean so that it heats and cools properly. These filters will capture the largest particles such as dust, hair, and dander. These are inexpensive filters and can be purchased at most DIY stores. Better filters will capture smaller particles. However, using higher-rated filters is not without cost. Higher ratings create more air restriction which can reduce air flow and cause problems with the equipment, they are more expensive, you may need larger filters or more, they need replacing more frequently, and they may increase the operating cost of your blower.

The type of blower in the system is an important factor in deciding what rating to use. Most conventional HVAC blowers cannot tolerate much restriction and ductless mini and multi-splits have no capability at all. Small-duct high velocity (SDHV) systems like Unico System on the other hand are designed for high pressure drops and can more easily incorporate the higher-rated filters.

For these reasons, Unico System standard filters are rated at least to MERV 7 (ENV779:2012 G4). As an option, Unico offers MERV 13 (ENV779:2012 F7) replacement filters with the caveat that sometimes the size of the filter must be increased, or you must use two.

³Zhang, John et al, "Study of Viral Filtration Performance of Residential HVAC Filters", ASHRAE Journal, August 2020

Temperature Regulation

Although often overlooked as part of IAQ, maintaining temperature for a home or building is probably the most important and obvious benefit of your HVAC system. This is the one function that all HVAC systems have in common and is the one thing that all HVAC systems do well although some systems are a bit better than others.



The main goal is to keep the temperature at a constant value per the occupant's desires. The best HVAC systems do a better job of minimising temperature fluctuations. This is very subjective but generally, most people are satisfied with keeping the temperature within a small range rather than constant.

Temperature is controlled by a thermostat and is either on/off control or modulating control. Smart thermostats try to anticipate when to turn on using advanced algorithms and learning how quickly the HVAC system reacts to change. Modulating control, either multi-stage or proportional control is the best control system although more complex and costly.

The Unico System is compatible with all third party 24Vac smart and multi-stage thermostats.

Odour Control

Odours associated with particulates such as smoke and cooking oils can generally be captured by normal air filtration, especially using the higher rated filters. However, odours from gases or chemicals can only be captured with activated carbon.

Several manufacturers of air filters offer models that have activated carbon impregnated into the filtration media. Activated carbon will not capture or destroy viruses. It primarily captures volatile organic compounds (VOCs) that can be harmful to persons with sensitive respiratory conditions and can shorten the life of your HVAC equipment and other electronics. VOCs can shorten the life of equipment by creating formic acid and other corrosive chemicals that attack the copper tubing and eventually cause refrigerant leaks. The source of VOCs is from various sources, including cleaning products, hair care products, cooking effluents, etc.

Humidity Control

Thermal comfort is not just temperatures. People give off moisture through breathing and perspiration, even if sitting on our couches. Showering, cooking and plant life also add moisture inside the house. Thermal comfort is affected by evaporation of this moisture and evaporation depends on the relative humidity in the room. Good comfort, where most people are satisfied, is within a narrow range of relative humidity. It should be between 45 and 55 percent. Less satisfactory but acceptable is at most 60% and below 40% starts to become dry and static filled air.

Increasing humidity requires that you add moisture into the air. This is often accomplished with a separate humidifier with its own controller, a humidistat. Like a ventilation system, the humidifier can be standalone or integrated into the HVAC system. Again, like ventilation, it is easier, less expensive, and more effective to integrate it with the central air system. And, again, this is not possible with ductless products.

Decreasing humidity requires that you remove moisture from the air. This is more difficult than adding moisture. The most cost-effective solution is to cool the air below its dew point to pull the moisture from the air. This strategy works well when cooling is needed but requires reheating the air if cooling is not needed. This is exactly what a dehumidifier does.

The problem with a dehumidifier is that it is energy intensive, so it increases the overall cost to condition the house. Luckily, dehumidification is mostly needed in the summer when cooling is also needed. Therefore, if the HVAC is designed to cool the air below

the dew point you get dehumidification at the same time. Some HVAC systems do a better job than others in this regard. SDHV systems, as an example, cool the air about 3 to 4 degrees colder than a traditional ducted system or a ductless system. This means it removes more moisture so the need for a separate dehumidifier is rare. Consequently, an SDHV system can be more cost effective than conventional ducted systems, even if rated at a higher efficiency, because the SDHV dehumidifies better⁴. Only in super tight, low load home applications would a dehumidifier be needed with an SDHV system and only for short periods of time.

Unfortunately, the HVAC controller, the thermostat, doesn't measure humidity. It can't control what it doesn't see. Humidity control, then, relies on the inherent dehumidification of the HVAC system such that one hopes it matches the moisture load of the house. If it is not up to the task, the occupants often decrease the set point of the thermostat until comfortable. This is energy wasteful and doesn't always improve comfort. It can also lead to IAQ problems with mold caused by surface condensation and high humidity.



⁴ Martin, Eric, Withers, Chuck, McIlvaine, Janet, Chasar, Dave, and Beal, David. Evaluating Moisture Control of Variable-Capacity Heat Pumps in Mechanically Ventilated, Low-Load Homes in Climate Zone 2A. United States: N. p., 2018. Web. doi:10.2172/1421385. Accessed April 2019 at <https://www.osti.gov/biblio/1421385-evaluating-moisture-control-variable-capacity-heat-pumps-mechanically-ventilated-low-load-homes-climate-zone>

Air Distribution

There cannot be good temperature regulation without good air distribution. The temperature controller (thermostat) only sees a single point, wherever it is located. It does not know if the rest of the house is at the right temperature. The occupants are rarely standing next to the thermostat and, like humidity control, the thermostat cannot control what it does not see.

Air is circulated inside the building. This means it is pushed into the rooms (supply) and then drawn out of the room (return) back to the equipment only to repeat the cycle. The supply air enters the room through a register. How well it mixes with the room depends on the design of the register, location, and air velocity. Traditional registers use relatively low velocity air with louvers to direct the air into the room with as wide a pattern as possible. This works well if you have good placement, lots of registers, and the returns are opposite of the supply registers. This is a rare design in a home.

A better solution is to use jets of air to induce mixing. This requires a high velocity air stream and no grilles to disrupt the airflow. The room air is then forced to mix, making it less important to direct the air into the center of the room or to locate the returns exactly opposite the supply registers. SDHV systems accomplish this better than traditional ducted systems⁵.

Ductless systems provide some air mixing but are not as effective as a central air system⁶. The supply and return are located exactly next to each other. This has a problem of short circuiting (some of the supply air never reaches the room) plus it requires that the supply uses higher velocity than a normal register (but not as high as SDHV) so that it reaches further into the room. Drafts and stratification are common.

Small Duct / High Velocity (SDHV) systems accomplish air distribution better than traditional HVAC ducted systems

⁵ Baskin, Evelyn, et al (2003). Thermal Comfort Assessment of Conventional and High-Velocity Distribution Systems for Cooling Season. ASHRAE Transactions, January 2003.

⁶ CEC (2019). Variable Capacity Heat Pump Performance Compliance Option. California Energy Commission Final Staff Report, Docket 19-BSTD-02.

Air Disinfection

Disinfection is the process of killing pathogens and destroying viruses. The Unico System[®] has the ONLY UV light designed for High Velocity systems.

There is only one known technology that can accomplish this while the occupants are in the room. If they leave, you can use chemical sprays. If there are occupants in the room, you can only use UV light. It must be the right kind of UV radiation and there must be precautions so none of the occupants are harmed. This type of disinfection has been used successfully for over 100 years in healthcare settings. Only recently, and with Covid-19, has it become popular to use in a home.

Again, like humidifiers and ventilation, the UV light can be standalone or integrated into the duct system. Standalone systems have small fans that pull room air into the device and exposing it to the UV light. They work well for a single room. This is an expensive solution for a whole house. A better solution is to install the UV light in the duct system. This is like a humidifier installation in that the UV light has its own control system.

Unico System is an SDHV system so the duct system is much smaller than a traditional duct system. There are several readily available UV lights that fit perfectly in the duct. The UV light cabinet makes it easy to install these, or if you prefer, Unico offers a cabinet with a pre-installed UV light.

SDHV does it All

Small-Duct / High Velocity systems are proven to have the most effective air distribution of any central air system. It dehumidifies better than any other system; has less air temperature stratification; is small enough to fit in any building and often inside the conditioned space for energy efficiency. And, being a central air system, includes the ability for air filtration, disinfection, and ventilation. Unico System goes further by standardizing with MERV 7 (ENV779:2012 G4) with an option for MERV 13 (ENV779:2012 F7) filters, providing an easy means to add UV light, and by integrating ventilation control in its blower control.



The Unico System[®]

3-in-1 heating, ventilation & cooling solution

Questions?



Visit us online at www.unicosystem.co.uk for more information about indoor air quality.

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01384 422 094



info.uk@unicosystem.com



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