



Performance
Matters **1st**

A BRIEF GUIDE TO INDOOR AIR FOR ELITE ATHLETES

IAQ – Indoor Air Quality

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A GUIDE FOR ELITE ATHLETES

The purpose of this guide is to help you as an elite athlete to gain a better understanding of how air affects your body and, therefore, your performance. The guide also explains how you can obtain simple and effective protection against air pollution, which is particularly important because you are training and competing at the highest level and breathing in a larger volume of air each day than “ordinary” people.

AIR IS ESSENTIAL FOR LIFE

Over the centuries, people have been both puzzled and fascinated by air. In 450 BC, the Sicilian philosopher Empedocles invented the concept of the four “roots”: air, fire, water and earth. This idea was developed further by Aristotle who called them the four elements. In 1493, Leonardo da Vinci designed the first helicopter-like craft with the aim of carrying people up into the air. The Dutch artist Hieronymus Bosch (1450–1516) painted pictures showing people in glass spheres taking off into the air and making their way out into space. We have always had a desire to move through the air. For centuries men have dreamed of flying and even of travelling beyond the Earth’s atmosphere. But air is not only a symbolic feature of our dreams. It is also essential for life.





THE CHALLENGES PRESENTED BY INDOOR AIR

A DEFINITION OF INDOOR AIR QUALITY

Indoor air quality (IAQ) is the quality of the air inside a building. It is defined on the basis of the concentrations and levels of incoming chemical and biological substances and the comfort-related factors which affect people and processes. The quality of indoor air is a factor that is often neglected and that has an impact on people's health, well-being and performance.

NEW TIMES – NEW CHALLENGES

Air pollution has been produced throughout the Earth's history. It ranges from natural volcanic ash to emissions from diesel vehicles and other forms of pollution caused by humans. As a result of our efforts to keep warm and live a comfortable life while keeping our energy consumption to a minimum, we have created indoor environments where we often fail to purify the air to a satisfactory level.

In the past, people simply had to deal with particles from wood smoke, sandstorms and other natural forms of pollution. In these cases, their bodies' in-built protective mechanisms effectively removed the worst of the pollution.

The past two or three hundred years of industrialisation represent a very short period in our history. This means that our bodies have not had time to develop defences against all the particles and other substances that are now found in the air. Physical defence mechanisms like coughing enable us to remove larger particles from our upper respiratory tract.

But the major problem is caused by the very smallest particles, which our bodies have no means of protecting us against, although we can cope with low levels of smaller particles.

INDOOR AIR

The basic idea behind ventilation is to mix indoor air with outdoor air. But because the outdoor air is now so polluted, as a result of different types of combustion processes and diesel exhaust gases among other things, several stages of purification are needed. If the air is not cleaned, there is a risk that indoor air will contain a very large quantity of harmful particulates which will find their way into people's respiratory tracts and circulation systems.



Effective filters in the ventilation system can prevent the majority of particles (and gases) in the outdoor air from making their way indoors, but they will not be able to stop a certain quantity of small particles from reaching the indoor air.

In modern indoor environments, the air is polluted not only by particles from outside which enter through the doors and windows and, to a certain extent, the ventilation system, but also by emissions produced by different materials inside the building. These emissions consist of particles and substances from furniture, paint, cosmetics, building materials, cleaning products etc. Emissions are also generated by cooking, log fires and

candles. Ozone can also be present indoors. This is a gas which is considered to be an air pollutant at ground level and which can lead to irritation in the respiratory system. The combined effect of many different substances and particulates in indoor air, including tiny nanoparticles, can cause problems for us. It is the very smallest particles and the gases (which have even smaller molecules) that have been shown to have a negative impact on our cardiovascular systems and to increase the risk of dementia.

MORE DANGEROUS INSIDE THAN OUT

Indoor pollution can be up to one thousand times more hazardous*) than the outdoor variety. This is because when particles and other substances pass into indoor air they combine in new ways with the substances and particles already present inside buildings. The combinations that can occur may be much more aggressive and, therefore, more harmful to us.

LOW LEVELS ARE BEST

We could protect ourselves fully from air pollution by spending all our time in clean rooms where the air is in principle completely purified. But we should not be aiming to achieve clinically clean indoor environments. That would not be good for us. In order to maintain a healthy immune system, we need to be exposed to a certain level of particulates, bacteria and other substances which reach us via the air and contact with other people.

VARYING LEVELS IN DIFFERENT PLACES

The requirements for creating a healthy indoor environment vary depending on where we live. The outdoor air is the factor which plays the most important role in this respect. By filtering out a significant proportion of the particles in the air which comes in from outside and using an air purifier to remove the pollution from indoor sources,

the indoor air quality (IAQ) can be improved considerably, even in places where the outdoor air is heavily polluted. Spending a day on the streets of Beijing will have the same negative effect on your respiratory tract as spending 30 days in Paris. And Paris has had major problems with air pollution in recent years caused by vehicle traffic, among other things.

A good guideline is that the air indoors should be around 50–70% cleaner than the outdoor air for reasons of health and comfort. This means that in Beijing, for example, it is possible to improve the quality of the poor indoor air until it reaches a level which is almost acceptable using the ventilation system alone. If a mobile air purifier is installed alongside the ventilation system, a consistently high level of air quality can be achieved, even if the amount of particulates and other substances in the outdoor air varies significantly.

It is also worth remembering that exposure to particles and other substances over a long period can be just as harmful as breathing poor quality air with a high pollutant content on one single occasion.

* WHO 1999



SOURCES OF POLLUTION, PLUS ADVICE

- Paraffin lamps produce more hazardous particles than candles. Scented candles give off artificial substances which can form deposits in our bodies. Tea lights made from paraffin have wicks that contain cadmium or lead to extend their burning time.
- Gas cookers emit particles which can harm our respiratory systems.
- Stoves and fireplaces without a chimney are not good for us. If you want to continue using them or cannot avoid doing so, make sure that the room is well ventilated.
- If you have a log fire, birch is the least harmful wood to burn because of its antioxidant levels.
- Cooking and, in particular, frying give rise to particles and other harmful substances which should be removed from the air immediately. It is also important to clean fan filters regularly and change molecular filters if these are installed.
- When mattresses, furniture and textiles are new, they give off high concentrations of softening agents and other substances, which can be harmful if breathed in. Airing mattresses and textile products will reduce your exposure.
- Electronic goods emit a variety of substances, particularly when they are new.
- Vacuum cleaners should be fitted with highly efficient HEPA filters which will help to reduce the amount of particles in the air.
- Regular and careful cleaning at home, at work and in other buildings will help to ensure that indoor air is more healthy and that the indoor environment is more productive.
- Do not use scent cartridges in your vacuum cleaner or perfume granules to clean your carpets.
- Do not use air fresheners. They do not remove unpleasant smells but simply cover them up with a different scent, which consists of particles and gases that are not good for your health.
- Ironing boards should not have a foam pad under their fabric cover, because this can give off harmful phthalates. If you cannot remove the foam rubber, you should not iron for more than 20–30 minutes at a time.



- Mites are responsible for around 3% of allergies. They are more likely to flourish in made beds than in unmade ones. To reduce their chance of survival, it is a good idea to leave your bed to air in the morning.
- Washing powder often contains zeolites, which can be released into the air during the washing and tumble drying process. Liquid detergents are a better option. They do not emit zeolites in such large quantities.
- Fresh paint on walls and other surfaces dries quickly, but the paint continues to emit various substances for a long period.
- The more air that comes in from the outside, the higher the oxygen content in the indoor air. Unfortunately, the quantities of particles and other substances also increases. It is important to find a healthy balance.
- Exhaust gases and other substances produced by a variety of combustion processes can enter buildings via their ventilation systems in excessive quantities, often as a result of poor-quality air filters which only remove up to half of the substances that are brought in.

WHAT IS HAPPENING INSIDE THE BODY?

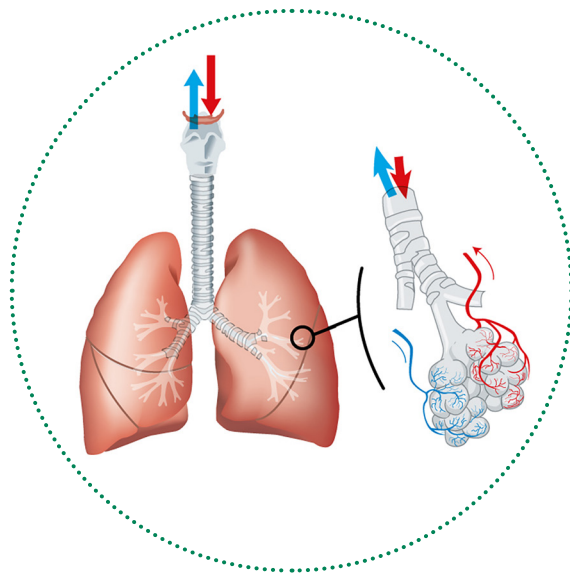
YOUR LUNGS AND CLEAN AIR

The function of the lungs depends on clean air even in the outermost of the seven million air sacs (alveoli) where the gas exchange with the capillaries takes place. The blood flows through the capillaries and gives off the carbon dioxide (CO₂) that has formed during the metabolic process. At the same time, it takes in oxygen via the alveoli. The oxygen is transported from the alveoli to the muscles and other organs. The carbon dioxide and other impurities leave our bodies when we breathe out.

Nanoparticles, which are no larger than a virus, can become deposited (trapped) in the cell membranes (walls) of the alveoli. These have a total surface area of around 70 m² and are highly sensitive to particles and harmful substances. If these substances remain in the respiratory system, they can contribute to the development of emphysema, oedema and other serious illnesses.

THE QUANTITY OF AIR PER MINUTE

When you are at rest, you normally take 12–15 breaths per minute. One breath consists of around half a litre of air. During strenuous exercise, you can breathe up to 60 times per minute. Your intake of air rises from 6–7 litres per minute when at rest to 100–120 litres per minute when you are working at your hardest. An elite athlete can breathe much more air/day depending of the volume of training. Because of this they also inhale more particles than a normal person.



THE AMOUNT OF PARTICULATES WE INHALE

If an elite athlete trains for 5 hours a day, sleeps for 8 hours and spends 11 hours doing ordinary everyday activities, he or she can take in approximately 73 m³ of air.

If we assume that normal outdoor air contains around 20 million particles per m³, this means that the elite athlete breathes in 1.4 billion particles which are 0.3 µm in size every day. By comparison, an ordinary person inhales 25 m³ of air per day. This includes 260 million particles that are 0.3 µm in size. Therefore, the elite athlete takes in 1.14 billion more particles during a day.

CLEAN AIR FOR BETTER RECOVERY

Given the overall impact of pollution on the lung tissues, in combination with other reactions, for a part of every day elite athletes need to breathe air that has been cleaned in order to reduce the volume of harmful particulates that they take in.

The inhalation of nanoparticles enhances calcium influx on contact with macrophages that weaken the immune system. This mechanism, combined with increased

oxidative stress from the higher number of inhaled particles, probably probably impacts our lung function and performance negatively. Clean air has a positive effect on our bodies and immune system, reducing the risk of inflammation and asthma. *

SYMPTOMS OF POOR AIR

Poor air quality has an impact on the body. Certain symptoms indicate that the air has a high particulate content and contains substances which do not belong there. Examples of warning signs which must be taken seriously include sore or itchy eyes, problems with wearing contact lenses, a runny nose, an irritated throat, headaches, tiredness and asthma-like symptoms.

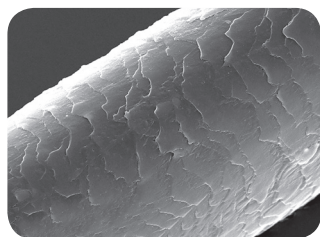
It is also worth mentioning that different people have different levels of sensitivity to poor air.

We do not always react in the same way to the quality of indoor air. It is possible to be affected by air pollution even if you do not experience any obvious problems.

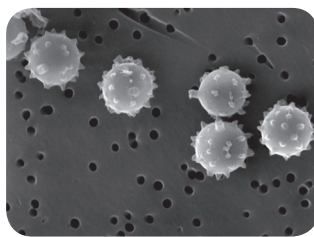
**Ambient particle inhalation and the cardiovascular systems: potential mechanisms. Ken Donaldson et al.*

THE SIZE OF PARTICLES

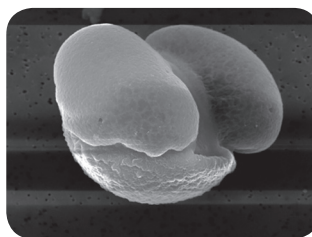
The smallest particles that can be seen with the naked eye are around 40–50 μm in size. (1 μm is one thousandth of a millimetre.) The particles with the greatest capacity for reaching the outermost areas of our respiratory system are very small, approximately 0.01–1 μm in size. The ability of different particles to form deposits (the degree to which they can become trapped in the body) depends on their size and whether they can pass through the walls of our airways, for example.



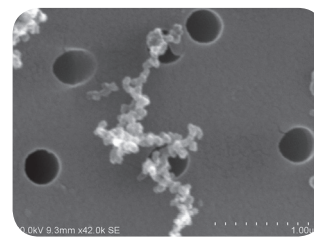
Hair: 70 μm



Spores: ~3–10 μm



Pollen: ~50 μm

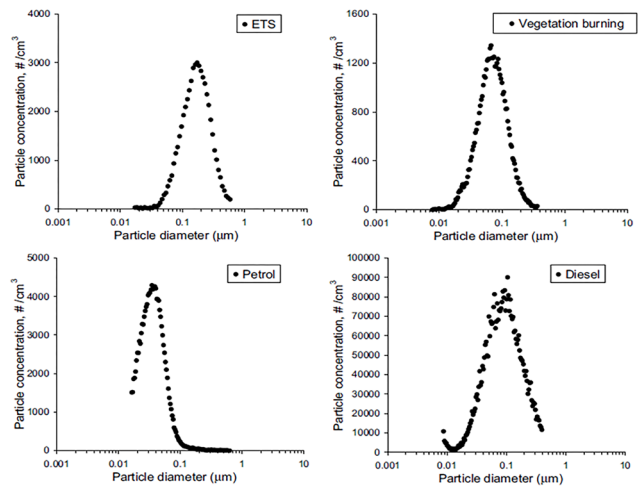
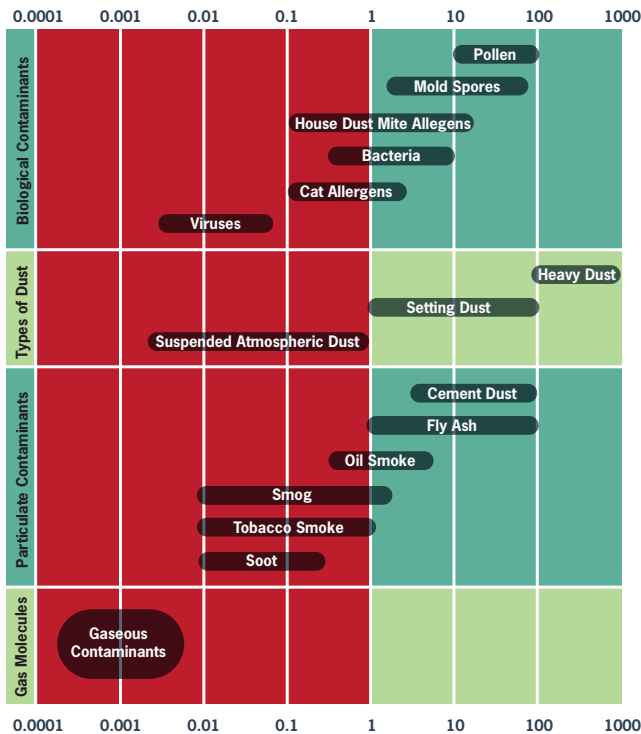


0.05 μm

Nanoparticles in an air sample which are stuck (clustered) together. Combustion particles.

Diagram showing the size of particles and gas molecules

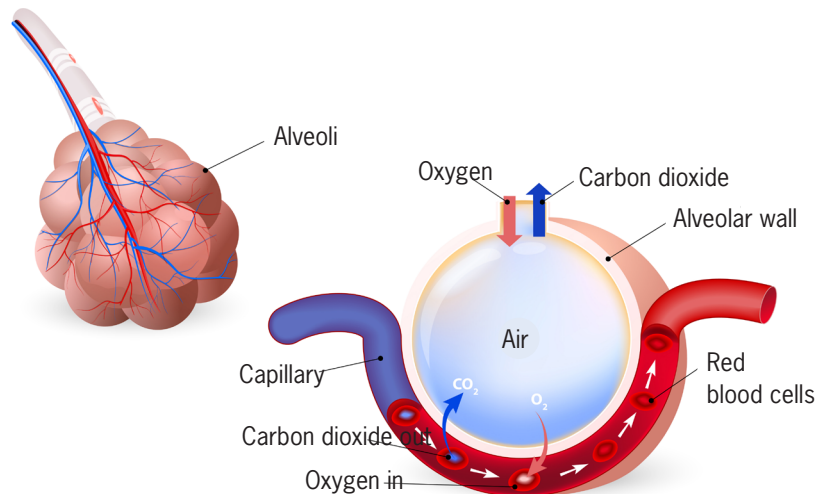
Diagram showing the size of particles and gas molecules in μm from 0.0001–1000 μm .



The number of particles produced by the combustion of different products in outdoor air

Four different substances: ETS (environmental tobacco smoke or passive smoking), wood smoke, petrol and diesel. Diesel produces the largest proportion of particles 0.1 μm in size at 90,000 per cm^3 , while wood fires emit the smallest proportion at around 1200 nanoparticles per cm^3 .

The membrane in the walls of the alveoli is the outermost area of the lungs where the gas exchange takes place with the blood. Carbon dioxide (CO_2) is transported out of the blood via the alveolar membrane and passes out of the body through the airways. Oxygen travels in the opposite direction through the channels in the membrane into the blood. Unfortunately, nanoparticles can also take the same route. Particulates and chemicals can disrupt the production of surfactants in the lungs, which leads to a reduction in lung capacity, because the volume of the alveoli reduces and the pressure in the lung tissues falls.





SUPPLEMENTING VENTILATION SYSTEMS WITH AN AIR PURIFIER

REMOVING PARTICLES FROM THE INDOOR AIR

Stationary or mobile air purifiers make the ideal complement for existing ventilation systems where the aim is to clean indoor air effectively. Even if the air has been cleaned by the filters in the ventilation system, there are a number of sources of particles and harmful substances inside buildings, as we have described on previous pages. All of these particles and substances can effectively be trapped by a high-quality air purifier.

A VARIETY OF DIFFERENT SOLUTIONS

An extensive selection of air purifiers which use different technical solutions is currently available on the market. These include mechanical, electrostatic, hybrid, plasmacluster and ionic air purifiers.

POINTS TO CONSIDER

However, there are some points to consider before making your final choice. **Electrostatic** and ionic air purifiers produce ozone, which is carcinogenic.

Hybrid systems have difficulties in achieving the required level of cleanliness and are often fitted with poor-quality air filters. **Plasmacluster** air purifiers remove VOCs (volatile organic compounds) from the air, but emit secondary substances and are ineffective at trapping particles. That leaves **mechanical** air purifiers, which we believe are the models that perform best and which we would recommend.

MECHANICAL AIR PURIFIERS

As the name indicates, mechanical air purifiers use mechanical filters. Depending on the manufacturer, they may be fitted with multi-stage filter systems, in other words both particle filters and molecular filters. Molecular filters are used to remove gases and odours. In addition, air purifiers should be equipped with a HEPA filter as the final stage of the filtering process in order to ensure that all the allergens in the air are trapped.

LOOKING UNDER THE COVER

The design of mechanical air purifiers can be important, in particular in the home, but it is the technology inside that plays the decisive role.

To get an indication of whether the model in question can perform as promised, it is a good idea to check the size of the filters. A large filter package, which should preferably have pleated filters, means a large surface area.

The larger the surface area of the filters, the more particles and harmful substances can be trapped. A large surface area also means that the air filter will be able to allow air to pass through for a longer period before coming clogged, which results in the air purifier using less energy.

These are the factors that determine how effectively an air purifier can clean the air, together with the class of the individual air filters. (This indicates the collection efficiency of the filter, which is its ability to trap particles, together with a low pressure drop, which means that it can maintain its ability to let air through.)

INTAKE ON TWO SIDES

Mechanical air purifiers take in air on both sides, rather than just one, which makes them twice as efficient. Another benefit of having two air intakes is lower energy consumption.

HIGH THROUGHPUT

In order to achieve the desired effect – clean air – the air purifier must have the capacity to clean the volume of air in the room at least once per hour. A class H13 air filter can help to achieve this. At the same time, the filter removes 99.95% of all particles 0.3 μm in size.

This means that the air released into the room is completely purified after the first cleaning process.

As a result, the air purifier will consume less energy than models with filters that are not tested to a specific standard, which the air has to pass through several times before being fully cleaned.



GREATER AWARENESS IS NEEDED SOLUTIONS ARE ALREADY AVAILABLE

In general terms, we still do not know enough about cleaning the incoming and existing air in our buildings or have enough control over the process. The majority of us have no idea what is in the air in the building where we spend most of our time. We are also unaware of the influence that the air has on us and of how harmful it can be.

We need to increase awareness and strengthen the regulations concerning the air in indoor environments, including our homes, workplaces and other buildings, such as training facilities.

Nowadays, there is a greater need for clean air indoors than outdoors in our part of the world, because we spend 90% of our time indoors and therefore the air there has a greater effect on us. The EU estimates that poor indoor air quality reduces the lifespan of the entire European population by seven million years of life each year.

Around 80% of properties in Sweden either have no systems for cleaning indoor air or have inadequate filtering of incoming air.

The costs of healthcare are often incurred at a later stage, after years of exposure to poor air. This also makes it difficult to identify which indoor and outdoor environments or which combinations of them caused the damage. An increase in knowledge and awareness of how polluted air can be cleaned will allow for healthier indoor environments in elite athletes' homes, in training facilities and in hotel rooms and other accommodation used at competitions or training camps.

The positive aspect of all of this is that by using relatively simple resources and making use of the knowledge and the technical solutions that are available, we can ensure that the air inside buildings is healthy and that these environments are productive, in other words, that there is good indoor air quality (IAQ).



CLEAN AIR PRODUCTS FOR ATHLETES

CLEAN AIR IN YOUR GYMNASIUM OR SPORTSHALL

In different gym environments there are different contaminants that can irritate your senses. From Chalk dust, small particles and odours. Camfil Industrial Air Cleaners are designed to protect your health in these environments



CC6000

CLEAN AIR IN YOUR HOME, OFFICE, WORKPLACE OR SMALL GYM

Quicker and improved recovery is key to all athletes. Ensure the Air Quality within your home is of the highest standard to aid recovery after workouts. Using EN1822:2009 Certified HEPA filters ensures Camfil Air Cleaners clean your air to the highest quality



City S



City M

OTHER CAMFIL CLEAN AIR PRODUCTS

Camfil are a world leader in the design and manufacture of Industrial air filters. Used in facilities ranging from Office buildings, Hospitals and Pharmaceutical facilities, Camfil Air filters guarantees the best air for your facility



Panel filter



Bag filter



HEPA filter

CAMFIL IS THE WORLD LEADER IN AIR FILTERS AND CLEAN AIR SOLUTIONS.

Camfil is the global industry leader in clean air solutions with 50+ years of experience. Our solutions protect people, processes and the environment to benefit human health, increase performance, and reduce and manage energy consumption. Twenty-five manufacturing plants, six R&D sites and over 65 local sales offices worldwide provide service and support to our customers. The Camfil Group is headquartered in Sweden but more than 95% of sales are international. The Group has around 3,800 employees and sales more than SEK 6.0 billion (2015).

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