camfil

PM_1 – FINE DUST HAZARD TO HEALTH

CLEAN AIR SOLUTIONS

FOCUS ON PM_1 FOR PROTECTION OF HUMAN HEALTH

Particulate matter (PM) sizes used to classify air quality, can be microscopic in size, with the smallest particles (PM_1) having the potential to do the most harm.

It is commonly known that air pollution is bad for human health. A much less known fact is that new research indicates the smallest particles in the air are the most dangerous.

To provide a healthy and productive indoor air environment, this means that the focus should be put on filtering particles that are 1 µm (micrometer) or smaller in size – particles also known as PM_1 (Particulate Matter 1).

PM_1 is the most severe to our health because the human body has no protection against very small particles. They enter our bodies through the respiratory system – we inhale them – and a significant portion goes deep into our lungs and continues into the blood stream.

At worst, **PM_1** particles contribute to deadly diseases such as heart attacks and lung cancer. Recent research has shown that small particles can contribute to the oncoming of dementia.

- Air pollution is responsible for 5.5 million premature deaths around the world each year.[1]
- Air pollution is the fourth highest risk factor for deaths globally and by far the leading environmental risk factor for disease.[2]
- WHO (the World Health Organization) has also concluded that the content of outdoor air pollution – for example particles from diesel fuel combustion – is carcinogenic.
- **PM_1** air pollutants are considered to be the most harmful by cognizant authorities. Fine particles in the air, measuring between 0,25 to 0,5 microns in diameter, have a closer relationship to human health, especially an increased risk of cardiovascular disease.[3]

Air filters that effectively remove PM_1 particles from the air will not only protect people from serious health problems, they will also help sustain the general well-being and productivity of people by preventing bacteria and viruses (which are often **PM_1** in size) from spreading through the human respiration system.

Another fact supporting the need to filter **PM_1** particles is that research[4] has shown that the smallest particles often account for more than 90% of all particulate matter in outdoor air. It is also known that the smaller a particle is, the longer it can stay suspended in the air, which means it can travel further – potentially up to hundreds of miles.

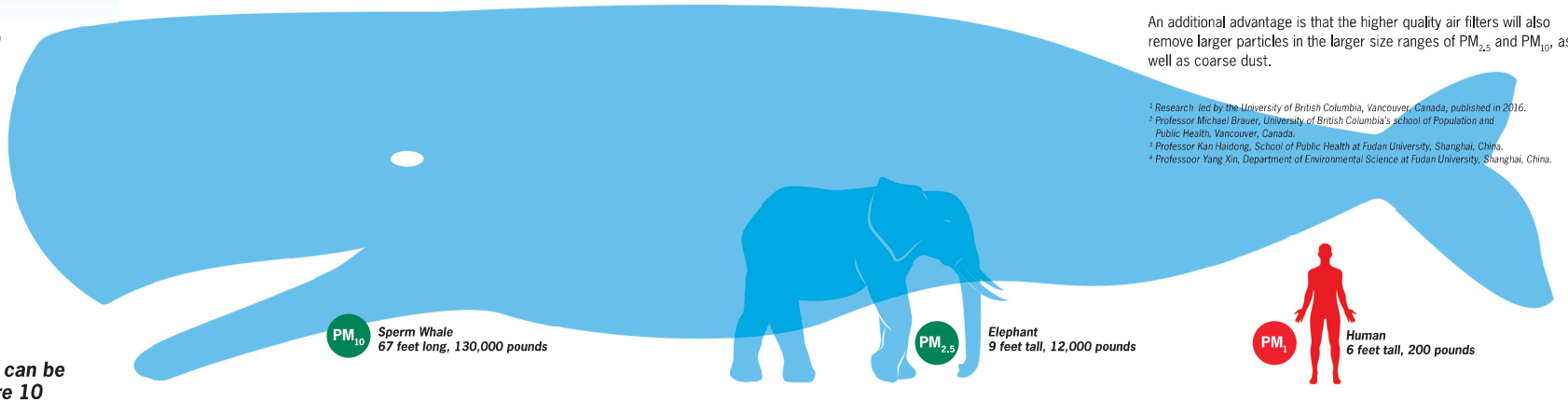
So how do you protect people from harmful micro-particles?
You do it by choosing high-quality air filters – MERV 13 filters or better – which have a filtration efficiency of at least 50% on **PM_1** particles (see table on page 7).

An additional advantage is that the higher quality air filters will also remove larger particles in the larger size ranges of $PM_{2.5}$ and PM_{10}, as well as coarse dust.

[1] *Research led by the University of British Columbia, Vancouver, Canada, published in 2016.*
[2] *Professor Michael Brauer, University of British Columbia's school of Population and Public Health, Vancouver, Canada.*
[3] *Professor Kan Haidong, School of Public Health at Fudan University, Shanghai, China.*
[4] *Professoor Yang Xin, Department of Environmental Science at Fudan University, Shanghai, China.*

HEALTHY OR NOT A MICROSCOPIC DIFFERENCE

EXAMPLE OF PARTICLES SIZES

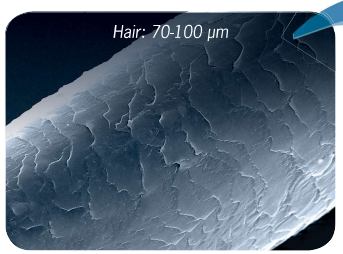


The smallest particles that can be seen with the naked eye are 10 um and larger in size.
(1 µm is one thousandth of a millimeter.)

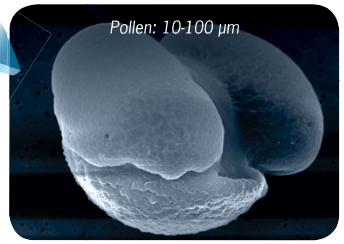
If a sperm whale was the size of PM_{10}...

$PM_{2.5}$ would be as big as an elephant...

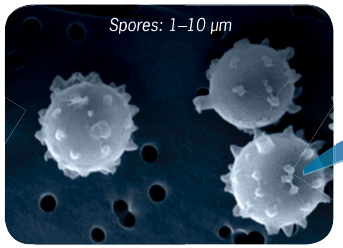
then PM_1 would be the equivalent of a human being.



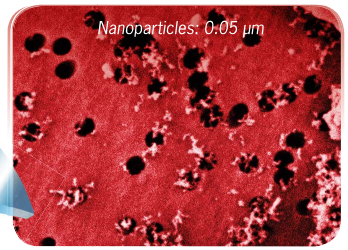
COARSE PARTICLES
Visible coarse dust and sand, leaves, hairs and other large organic particles.



PM_{10}
Smoke, dust, dirt and pollen. Coarser fine dust and larger organic particles.



$PM_{2.5}$
Larger spores and other organic particles.



PM_1 – HEALTH AND HYGIENE
Very fine dust, combustion particles, nanoparticles, bacteria, viruses and smaller spores.

PM_1 WHAT IS HAPPENING INSIDE THE BODY?

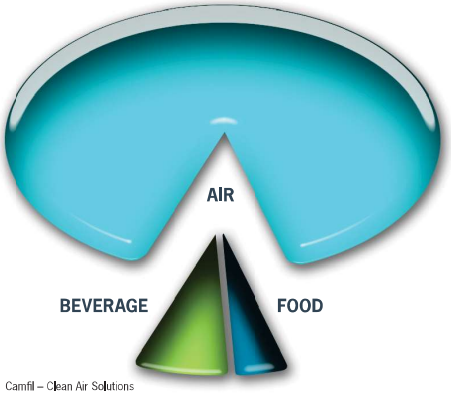
The particles with the greatest capacity for reaching the outermost areas of our respiratory system are very small, approximately 0.01–1 µm in size – **PM_1**. The ability of different particles to form deposits (the degree to which they can become trapped in the body) depends on their size and whether they can pass through the walls of our airways.

YOUR LUNGS AND CLEAN AIR

The function of the lungs depends on clean air even in the outermost areas 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 (CO_2) that has formed during the metabolic process. At the same time, it takes in oxygen (O_2) 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 750 square feet 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, as well as premature deaths.

EVERY DAY WE EAT 3 POUNDS OF FOOD, DRINK 5 POUNDS OF BEVERAGES AND BREATHE 67 POUNDS OF AIR!



COARSE DUST
Particles 10 µm in diameter and larger. The human body is able to "filter" coarse particles in the nose via the nose hairs and mucous membranes. Limited health impact.

PM_{10}
Particles 10 µm in diameter or smaller can reach the respiratory ducts and potentially cause decreased lung function.

$PM_{2.5}$
Particles 2.5 µm in diameter or smaller can penetrate the lungs and cause decreased lung function, skin and eye problems, etc.

PM_1
Particles 1 µm in diameter or smaller. A significant number of PM_1 particles are tiny enough to enter the blood stream and can be the cause of tumors, cardiovascular diseases, dementia, etc.

Scientists have linked the exposure of fine particles to:

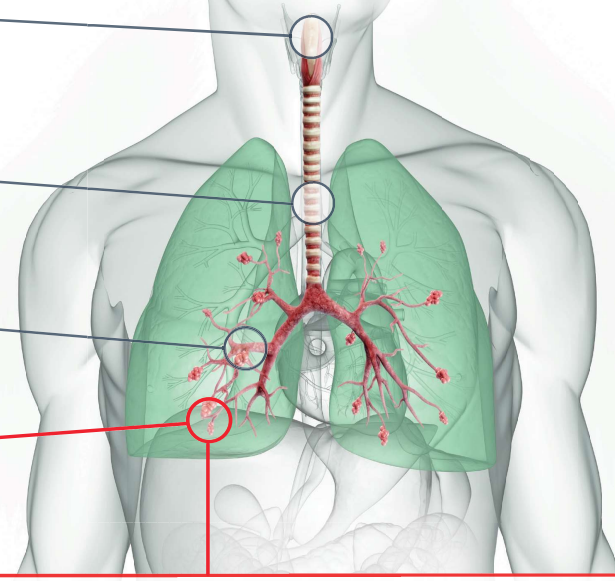
- Cardiovascular disease
- Reproductive problems
- Impaired immune system
- Premature death
- Cancer
- Diabetes
- Asthma
- Alzheimer's

SYMPTOMS OF POOR AIR

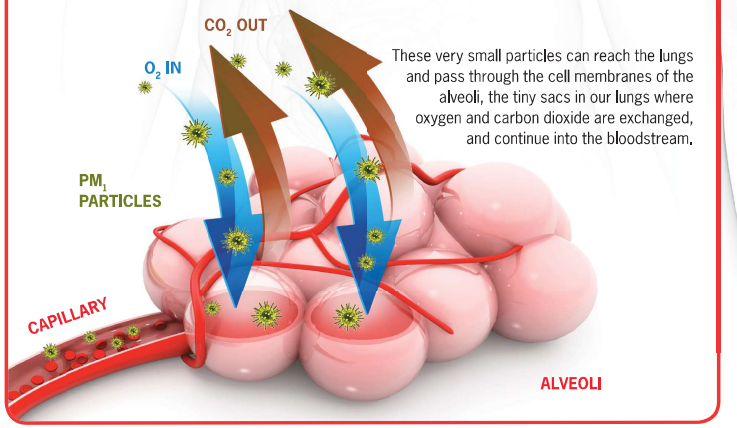
Poor air quality has an impact on the body. Certain symptoms indicate that the air has a high particulate content and contains substances which can cause health issues. Examples of warning signs which must be taken seriously include sore or itchy eyes, problems with wearing contact lenses, runny nose, irritated throat, headaches, tiredness and asthma-like symptoms.

It is important to recognize that different people have different levels of sensitivity to poor air. Humans 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 there are not obvious symptoms or problems.

PM_1-PARTICLES: INVISIBLE AND VERY DANGEROUS!



WHAT HAPPENS WHEN PM_1 PARTICLES ARE INTRODUCED INTO THE BLOOD VIA THE ALVEOLI



These very small particles can reach the lungs and pass through the cell membranes of the alveoli, the tiny sacs in our lungs where oxygen and carbon dioxide are exchanged, and continue into the bloodstream.

PARTICLE SIZES OF COMMON CONTAMINANTS

Indoor Air

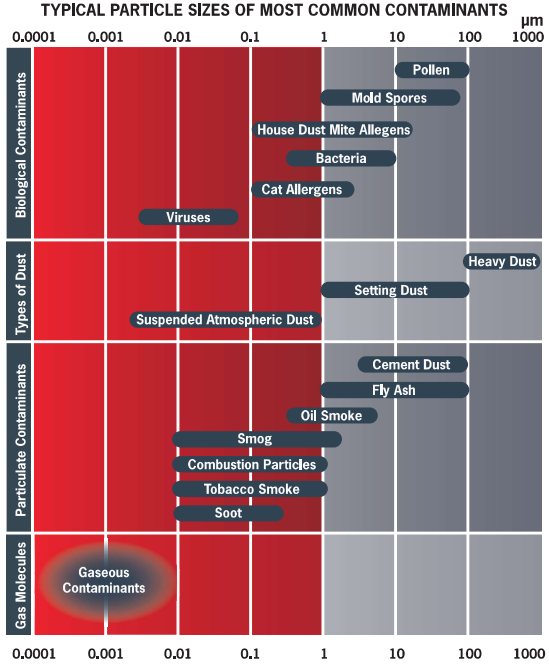
The basic idea behind ventilation is to mix outdoor air with indoor air to assure proper air quality for building occupants. But because the outdoor air is now so polluted, as a result of different types of combustion processes, diesel exhaust gases and other contaminants that are a by-product of our society, 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 that 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.

The diagram (right) shows the size of particles and gas molecules in µm from 0.0001-1000 µm. PM$_1$ particles are shaded with red.

Using the Right Filter

The number one consideration for selecting an air filter should be for its ability to protect people or critical processes. Other factors may include a filter's energy usage, its configuration for ease of installation into a system and whether it will maintain its published efficiency throughout its lifetime.



The Hi-Flo® ES and Durafil® ES are both available in efficiencies of ePM$_1$-50, ePM$_1$-70 and ePM$_1$-80 to remove the smallest particles from the airstream while at the same time saving 30% or more in energy when compared to other air filters. Most Camfil products exceed the ePM values listed above, see product literature for actual testing values.

HOW TO CHOOSE THE RIGHT AIR FILTERS

Air filters protect people's health by maintaining a good hygiene level in the ventilation system. For maximum protection from PM$_1$ and larger PM sizes, choose high-quality air filters with a filtration efficiency of 50% or higher – see tables below.

ASHRAE 52.2 Standard

Always look for a filter's MERV-A rating. When MERV and MERV-A are the same, that filter will maintain its efficiency throughout its life.

ASHRAE 52.2 – TYPICAL EFFICIENCIES OF AIR FILTERS AGAINST PM$_1$ AND OTHER FINE DUST MASS CONCENTRATIONS

Filter class	PM$_1$	PM$_{2.5}$	PM$_{10}$
MERV 10 (10-A)	<20%	<40%	>50%
MERV 11 (11-A)	<40%	50-60%	>60%
MERV 13 (13-A)	50-75%	>70%	>80%
MERV 14 (14-A)	70-85%	>80%	>90%
MERV 15 (15-A)	>85%	>90%	>95%

OLD VS. NEW STANDARD

ASHRAE Standard 52.2 – Old Standard

ASHRAE Standard 52.2 provides a minimum efficiency reporting value (MERV). An additional testing step is used to determine whether the air filter will maintain its efficiency throughout its lifetime; MERV-A, the MERV and MERV-A value should always be the same. When the MERV and MERV-A are the same, it means a filter will maintain its efficiency throughout its life.

ISO Standard 16890 – New Standard

A new global standard - ISO 16890 for air filter testing and assessment, is likely to replace ASHRAE Standard 52.2 in the near future. Using the new method of testing air filters, efficiencies will be determined and classified based on the particulate classes of PM$_1$, PM$_{2.5}$ and PM$_{10}$, the same evaluation parameters used by the WHO (World Health Organization) and environmental agencies around the world to determine acceptable air quality.

In ISO 16890, the particulate class is followed by a number which is the filter's efficiency within that PM class range. For example, a filter with a rating of ePM$_1$-70%, would have an initial removal rate on PM$_1$ particles of at least 70%. The ISO standard also includes a discharge procedure, as part of the standard, that exposes filters that may lose efficiency over time. This is critical for designers and end users that want to ensure that the filter efficiency they are applying will be the filter efficiency in their systems throughout the life of the filter.

To determine what air filters are best for your facility contact your local Camfil office. Some general guidelines follow:

Facility Type	ASHRAE 52.2 Efficiency Recomendation	New ePM Efficiency per ISO Standard 16890 Recomendation
Commercial Office Space	MERV 13/13A	ePM$_1$-50%
Schools & Educational Facilities	MERV 13/13A	ePM$_1$-50%
Medical Facilities	MERV 14-14A	ePM$_1$-70%

CAMFIL is the world's largest and leading manufacturer of filters and clean air solutions.

Camfil is the global industry leader in clean air solutions with more than 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 65 local sales offices worldwide provide service and support to our customers. The Camfil Group is headquartered in Sweden with 95% international sales. The Group has approximately 3,800 employees and sales approaching 800 million dollars.

1 North Corporate Drive | Riverdale, NJ 07457
Phone: 973.616.7300 | Fax: 973.616.7771
camfil@camfil.com
www.camfil.com

www.camfil.us

For further information please contact your nearest Camfil office.