

## Is it really necessary to ban the use of wood-burning stoves?

More emphasis on environment and pollution has increased the scrutiny on emission levels from wood-burning stoves and other fireplaces, particularly in densely populated urban areas. Especially the emissions of fine and ultrafine particles are a source of concern as these particles are likely to have negative consequences for our health (although the evidence for this is not yet conclusive). Instead of banning the use of wood-burning stoves – which contributes with CO<sub>2</sub>-friendly heating in many homes – a more fruitful approach may be to adopt already existing filter technology.

### What is a particle and where does it come from?

Particles come in many different shapes and sizes. They can be liquid droplets or solid particles, they can be shaped like spheres, faceted crystals or needles, and they can be irregular clusters of smaller particles. Particles are categorised based on their size. Particles smaller than 0.1 µm are called *ultrafine* particles, particles smaller than 2.5 µm are called *fine* particles, while particles larger than 2,5 µm are referred to as *coarse* particles.

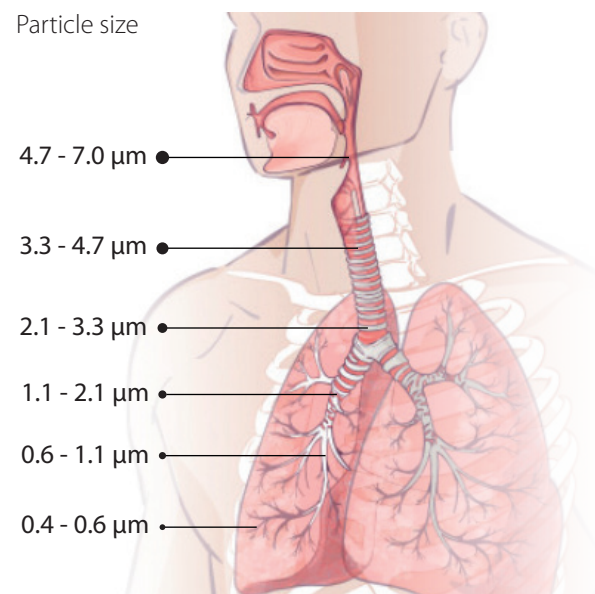
Descriptor	Size (diameter) in µm	Size in nanometres (nm)	Weight factor
Nanoparticles	< 0.02	< 20	0.000001
Ultrafine particles	< 0.1	< 100	0.001
Fine particles	< 2.5	< 2500	1
Coarse particles	> 2.5	> 2500	1

Ultrafine particles and nanoparticles are formed during combustion processes, for instance in engines and power plants, as well as in various industries. Burning of biomass also releases particles smaller than 0.1 µm, regardless of whether the burning occurs in nature, as in the case of a forest fire, or as a result of human agency, as in the case of domestic wood burning. Finally, particles can be formed when gas molecules fuse together, i.e. the conversion of gas into particles (condensation).

### What are the effects of particles on humans?

Due to their small size and chemical composition, fine and ultrafine particles pose a serious health hazard as they can penetrate deeply into our respiratory systems, enter our lungs and cause a variety of diseases, from chronic cough to cardiovascular disease and lung cancer. In severely affected environments, a person could potentially inhale millions of particles with a single intake of breath.

Our respiratory systems are equipped with natural filters for coarse particles, which are absorbed in the nose and throat and coughed back up. Fine and ultrafine particles, however, are a different matter as they can enter our lungs and alveolae. Particles with a size between 0.1 and 1 µm can even enter the bloodstream and body tissue where they attach themselves and react, in some instances causing cancer. To make matters worse, fine and ultrafine particles are much more prevalent than coarse particles.



Ultrafine particles are the most dangerous as their small size allows them to enter our alveolae, and, from there, continue into our bloodstream and body tissue.

## How are particles measured today?

Today, measurements of particle emissions from fireplaces (wood-burning stoves, pellet stoves etc.) are carried out on a weight basis (particle mass [PM]), meaning a predefined amount of wood is burned off and the particles released with the flue gas during combustion are weighed.

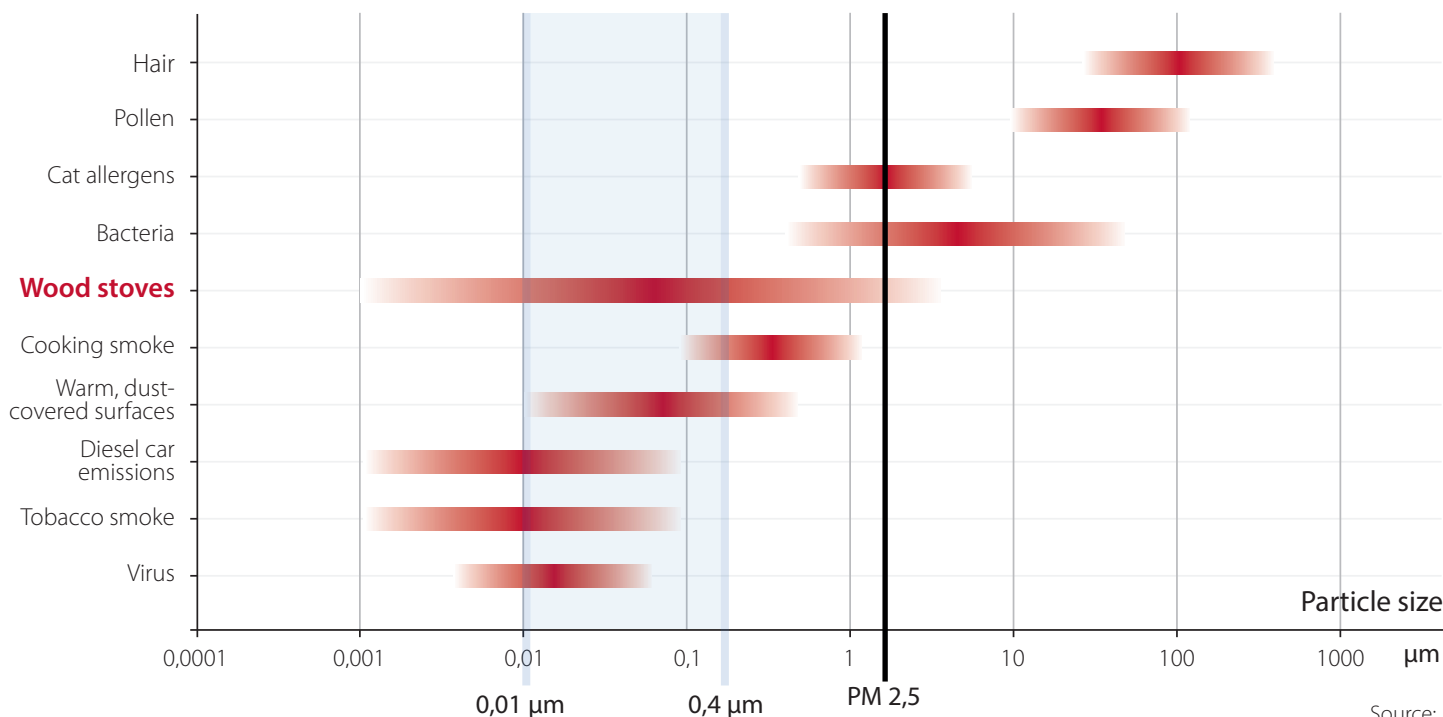
Wood stoves and other fireplaces have been optimised over the years so as to release considerably less particle mass than previously. Unfortunately, it is only the larger, heavier particles that are removed as a result of these optimisation efforts. Combustion in newer types of wood-burning stove occurs at a higher flame temperature, which generates an abundance of fine and ultrafine particles. These particles weigh so little that a measurement based on weight alone is bound to miss them. For that reason, it is paramount that the industry begins to measure the *amount* of fine and ultrafine generated by wood stoves and other fireplaces. By measuring particle numbers in cooled flue gas, the pollution levels can be more accurately determined, along with the most efficient technological measures for reducing them.



exodraft particle filter mounted on a steel chimney

## Where are particles measured today?

Measurements on particle emissions from wood burning can be carried out on hot flue gases in accordance with the EN13240 standard, or on cooled, diluted flue gases in accordance with the Norwegian NS3058 standard. The latter method takes into account the secondary particles that form during cooling (condensation) of the flue gasses, thus providing measurements with higher particle concentrations. For this reason, measurements on cooled flue gasses are more representative of realistic particle emissions to the outdoor environment than measurements carried out on hot flue gasses.



Source:  
Hvilken virkning har luftrensning på indeluftens indhold af partikler...  
Lars Gunnarsen, Aalborg University

## How should particles be measured from now on?

In order to accurately determine the emission levels from fireplaces, particles should be measured and counted with the proper measuring equipment, and not simply weighed. **exodraft** and PHX innovation have accumulated a vast know-how on the proper procedures for measuring particle numbers in condensed flue gas. By applying this know-how, the actual emission levels and filtration rates can be determined.

## How to reduce the particle emission from fireplaces?

**exodraft** flue gas particle filter ESP-10 is designed to remove the hazardous fine and ultrafine particles from the flue gas of wood-burning stoves and other fireplaces. The ESP reduces the number of particles by up to 95% (fine and ultrafine particles) and reduces the total particle mass by 70-75%. Measurements were carried out in accordance with the Norwegian NS3058 standard, which provides a realistic picture of the amount of particles released to the outdoors. The electrostatic precipitator is installed on top of the chimney and uses a high-voltage electrode to charge the flue gas particles, causing them to collect inside the filter. **exodraft's** wood stove filter has an automatic cleaning function, which maintains a high filtering efficiency and reduces maintenance.

## How does the wood stove filter work?

An electrostatic precipitator (ESP) is built on the following principles:

1. Generation of high voltages
2. Charging of the particles with high voltages
3. Separation and clustering of the particles by the forces of electromagnetism

As soon as voltage is applied to the electrode, an electric field is generated around it. If the voltage is sufficiently high, the electric field will be powerful enough to charge the particles in the flue gas stream, causing them to stick to the inner walls of the filter where they clump together for easy removal.

## Ban or backing?

Wood burning has a considerable downside in that it releases particles that are potentially harmful to us. One solution could be to put down a ban and set up disposal incentives on wood stoves, but this would do away with a lot of good primary and secondary heat sources in people's homes. Wood burning is a sustainable and CO<sub>2</sub>-friendly way of heating a house. A backing initiative to support particle reducing technology instead could save the wood burning tradition while helping to remove harmful particles from the air we breathe.



## The future of particle emissions from wood stoves and fireplaces

The future of the wood-burning stove is likely to contain tighter regulations and clearly defined limits on particle emissions in order to maintain the quality of our air. The first step in this direction has already been taken in Germany where the "Blauer Engel" (Blue Angel) eco label has put stricter demands on emission levels from wood stoves and fireplaces, but also – for the first time ever – a limit on the *number* of particles released by any one fireplace. Demands such as these can only be met with particle reducing technology.

Sources:

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