

# Why Filtration Technology has a critical Influence on the Removal of Airborne Pollutants

The manufacturing industry is characterised by a multitude of processes. From joining and separation technologies by means of laser, soldering and gluing, surface processing such as drilling, sintering and milling, and the utilisation of fluxes or production processes such as rapid prototyping – there is a wide range of various technologies. All these procedures have one thing in common: they generate harmful particles of any size, form and composition. These particles have an undesirable effect as they have impact on humans, machines and products because of their chemical and physical characteristics. They can cause diseases, affect machine functionalities and pollute products, thus can be responsible for malfunctions and production failures.

## It's not Enough Merely to Extract

Utilising an extraction system seems logical. Indeed, it is. However, systems vary in effectiveness and many critical parameters must be considered when selecting the most suitable extraction and filtration system. In order to completely removing all occurring dusts, fumes, odours, gases and vapours it is necessary to utilise the appropriate filtration technology and understand all the characteristics of the airborne pollutants and processes. A distinction is made between particulate and gaseous substances. Partially, gaseous substances may react and become particles. Modern procedures such as welding, laser or other thermal processes cause the emergence of particles, which become increasingly smaller and some are known to be in the nano range.

Particle size is one criterion that decides on the utilisation of the best suitable filter medium.

Additionally, knowledge on particle characteristics (adhesive, condensing etc.), gas content or flammability is important. These factors also have influence on the selection of the ideal filter.

## Air Filters and their Subdivisions

Filtration means separation of solids and gases, and there are many techniques used:

- Gravity separators (e.g. settlement tanks)
- Centrifugal separators (e.g. cyclones)
- Wet separators (e.g. washers)
- Electric separators (electrostatic filters)
- Filtering separators (fabric filters, cartridge filters)
- Adsorptive filters (e.g. activated carbon)

This article focuses on filtering separators, also known as bag filters and fibre filters, as they are used across a wide range of industrial sectors.

The German association VDMA (Verband Deutscher Maschinen- und Anlagenbau/German Engineering Federation) subdivides filtering separators into different classes (image 1). Thus, a distinction is made between fine particulate (according to DIN EN 779:2012) and coarse particulate air filters (according to DIN EN 1822:2011)<sup>1</sup>.

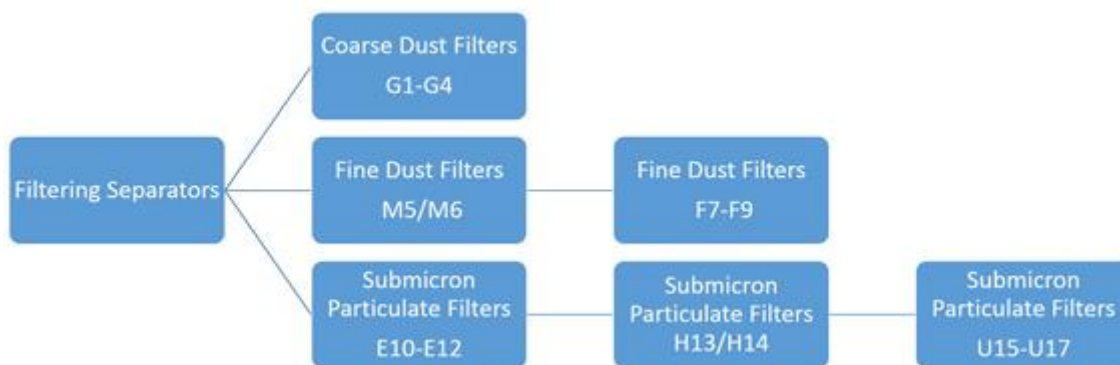


Image 1: Classification of filters

Particle size is critical for the selection of filter type. With a given air volume and filtration efficiency, the following parameters are key variables and performance figures for practical sizing of air filters:

- Incoming particle characteristics
- Initial pressure drop and pressure drop progression
- Lifetime or possible duration of usage<sup>2</sup>

Filter performance (degree of separation/efficiency), pressure drop and particle type are the most essential criteria for selecting best suitable air filter. In addition, the first two criteria have a critical influence on energy issues, which should also be considered.

<sup>1</sup> VDMA Luftfilterinformation (2015-02), VDMA, Allgemeine Lufttechnik, February 2015

<sup>2</sup> „Grundlagen der Filtertechnik“. Luftfilterbau GmbH, V2.4, 5/2012

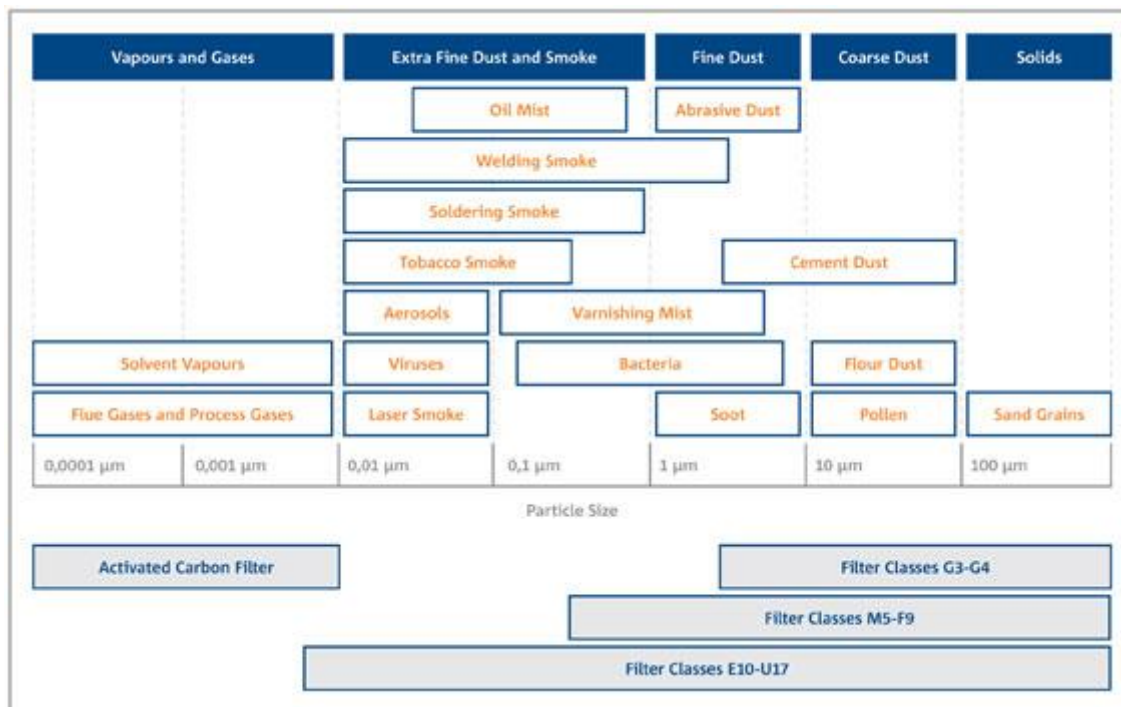


Image 2: Filter classes in accordance with particle sizes

### Coarse Particulate Filters/Saturation Filters

Coarse particulate filters are commonly used as pre-filters. Primarily, they separate coarse dust types  $>10\ \mu\text{m}$ . In industrial applications, configurations as filter mats, filter cassettes, pocket filters, metal mesh filters or wire frame filters are well proven. Since coarse particulates are mainly dry dusts, this filter selection is based on the percussion effect, i.e. due to their inertia forces particles are bound on the filter surface. After the formation of a so-called filter cake and respective saturation, the filters can be cleaned/dedusted and reused. The precondition is a constant air flow.

The benefit of saturation filters is the low initial investment and high flexibility, but set against high maintenance and operation costs.

### Fine Particulate Filters/Storage Filters

Fine dust filters are primarily used for separating airborne pollutants  $> 1\ \mu\text{m}$ . Although they are available as pocket filters or compact cassettes, their utilisation as cleanable or regenerative filters, e.g. in the form of cartridge filters has been proven in industrial applications. Long life is the benefit of cartridge filters, i.e. their separation efficiency is constantly high also in case of varying air flow (up to 98%).

Further advantages are low maintenance and energy costs. Cartridge filters, however, are less flexible and require a higher investment.

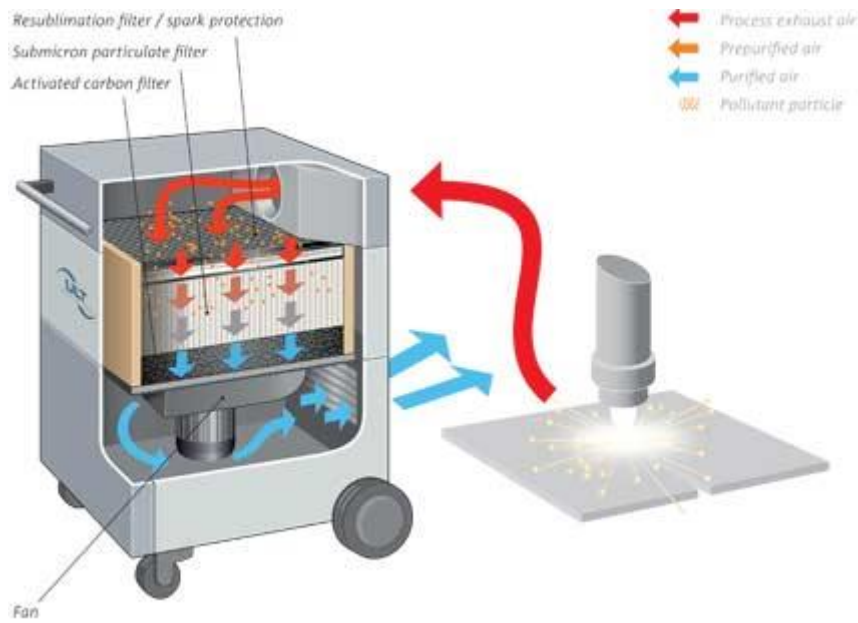


Image 3: Principle saturation filter system

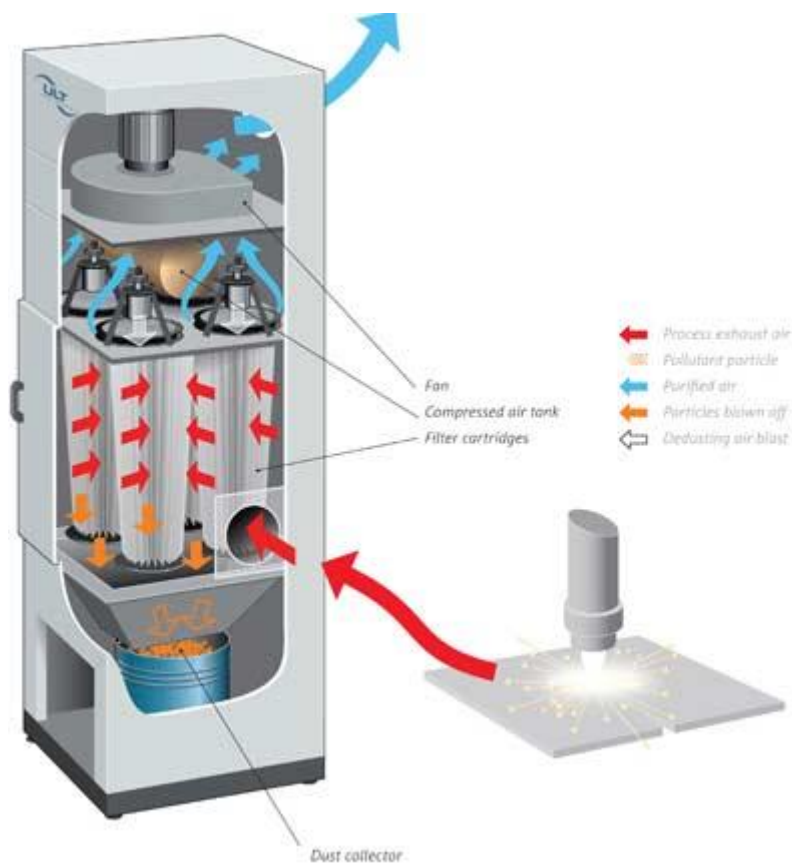


Image 4: Principle cartridge filter system

### *High-efficiency Submicron Particulate Filters*

Processes that apparently generate fewer pollutants are particularly critical, because low quantities of emissions in the nano range no longer effect an agglomeration, and nanoparticles keep their sizes ( $< 1 \mu\text{m}$ ). These extremely fine particles enter the lungs and blood, and might in the worst case result in a shortened life expectancy. The utilisation of HEPA filters/H-class filters (High Efficiency Particulate Air Filters) is critical for effective filtration. HEPA filters are used for air purification of up to 99.995%.

They are primarily utilised as storage filters in the form of cassettes. In cleanroom technology, they are also used as plate filters or fan filter units (FFU), which means a combination of HEPA filters with controlled fan or prefilter.

ULPA filters (Ultra Low Penetration Air Filters) are applied if the air flow has to be nearly particle free (degree of separation from 99.9995%).

### *Modular Systems*

Airborne pollutants are usually a mixture of coarse and fine particles – processes often produce particle sizes between  $>1 \mu\text{m}$  and  $<10 \mu\text{m}$ . In practice, extraction and filtration systems that combine the advantages of both filter principles are well proven. Such units are specifically developed to meet special application requirements.

Additional benefits are the availability of the equipment, price-related attractiveness as well as flexibility if application conditions change.

### **Adsorption of Gaseous Air Pollutants**

Gaseous and vaporous substances can be stored in activated carbon or other sorbents. Activated carbon is made of organic materials (e.g. peat or nutshells) and provide an adsorption-capable surface of up to  $1,700 \text{ m}^2/\text{g}$ . This means an extremely high degree of separation and an enormous storage capacity, which finally results in very high filter life.

If particle concentrations are higher, combustion processes seem reasonable. In terms of energy, they are only profitable if the combustion process is stable and runs without additional power supply.

Catalytic processes represent an intermediate stage. They always require a constant contaminant mixture. Overall, sorbents provide a better flexibility but need a strict obedience to organisational measures or change intervals.

### **Pollutant Capturing**

Quality of pollutant collection is the linchpin of extraction and filtration technology. Basically, the appropriate capturing element can deliver a substantial contribution to the quality of the extraction and filtration device. The degree of capture rate forms the basis for subsequent high-grade filtration, finally providing high overall efficiency and low residue in the returned clean air.

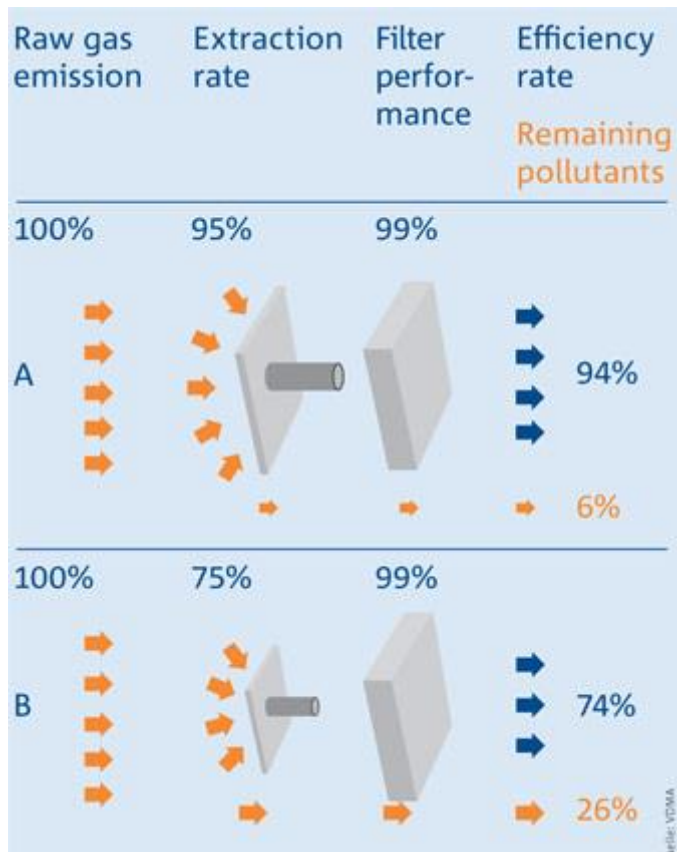


Image 5: Impact of the extraction rate on efficiency (source: VDMA)

In particular, capture at the source of the pollution generation is of critical importance. A general rule says that twice the distance between emission source and capturing element requires four times the exhaust performance in the extraction and filter system. That gives an exponential conclusion to the energy requirement – in times of energy conservation a remarkable aspect.

### Extraction and Filtration Means Foremost Self-Protection

Extraction and filtration systems have their unquestioned positions in many companies – in manual workplaces, in automated and semi-automated production lines.

Occupational health and safety (OH&S) protection in manufacturing companies as well as in laboratories has gained importance in recent decades, because the impact of airborne pollutants on employees, machines and products has a critical influence on production and profitability.

The maintenance of production equipment, accuracy of product quality and functionality, as well as OH&S measures can generate high costs. It should be the goal of any company, which produces high-quality goods, to minimize these costs. The most suitable extraction and filtration system will help.

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