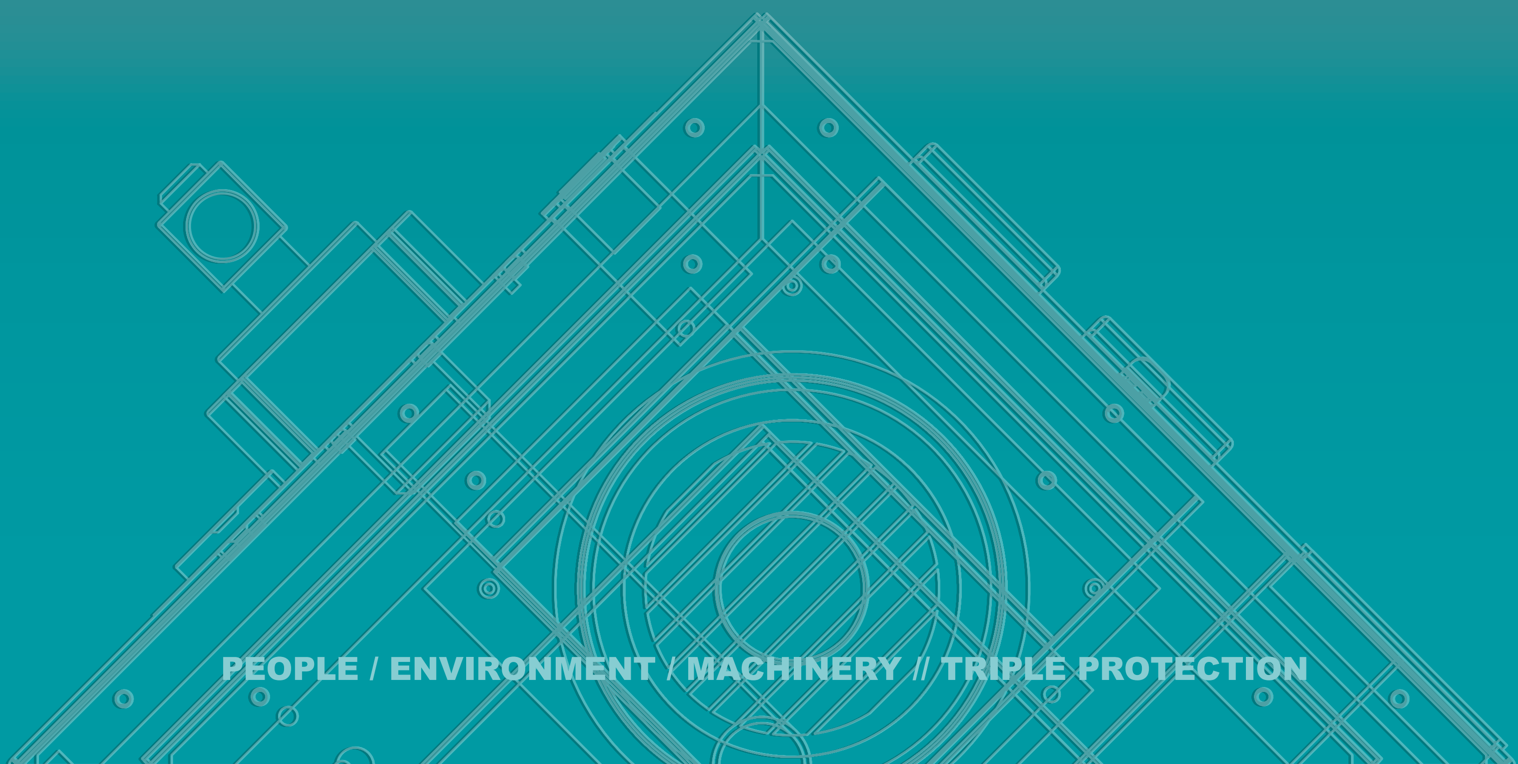
TBH®

EXTRACTION / FILTER / POLLUTION CONTROL // TECHNOLOGY

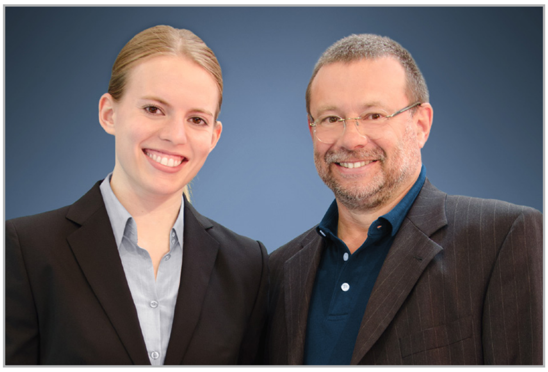


PEOPLE / ENVIRONMENT / MACHINERY // TRIPLE PROTECTION

CONTENT

Dear interested parties and TBH customers,

this company presentation from TBH GmbH provides an introduction to our range of services. The “WORTH KNOWING” section will help you to become familiar with extraction and filter technology.



We hope this will serve as a handy reference guide in designing an ecologically compatible workplace.

The TBH TEAM and our partners in the respective countries will be glad to advise you about TRIPLE PROTECTION for PEOPLE, THE ENVIRONMENT and MACHINERY.

We would love to hear from you.

Your TBH GmbH

Udo Hartmann Solvejg Hartmann

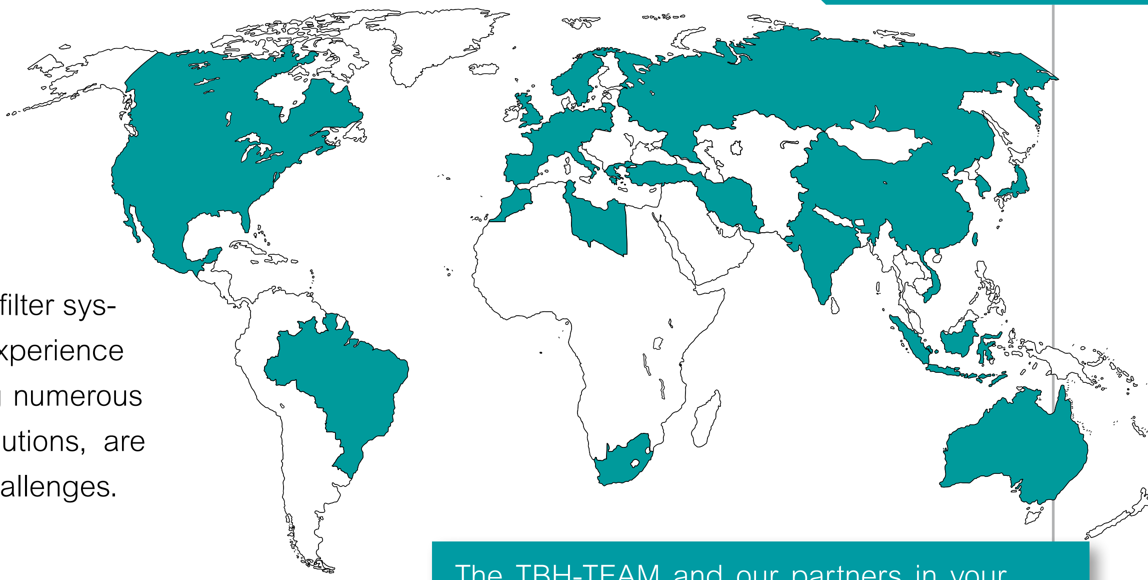
ABOUT US

From the Black Forest to the Entire World

TBH GmbH is a independently owned company located in Straubenhardt (Baden-Württemberg), Germany and is one of the market leaders in the field of high-quality extraction and filter technology for industrial and medical applications. TBH products are currently to be found in more than 80 countries across the world. Our philosophy, is to design products which fully meet international and local quality standards.

Of course, we aim to give our customers the best possible service. At TBH our staff who are highly trained and able, in an open minded and reliable way, to support your efforts to establish contaminant-free workplaces.

Our high-quality TBH filter systems, together with experience gained by developing numerous customer-specific solutions, are ready to meet your challenges.



The TBH-TEAM and our partners in your country are looking forward to providing solutions to your fume extraction problems.

TBH GmbH company building in Straubenhardt, Germany

QUALITY

Quality is the Standard

TBH extraction and filter systems of course comply with all of the relevant EC directives and standards. As an international company, we are also geared towards certification of our products in accordance with guidelines and standards that are applicable worldwide. This is verified by a number of independent testing institutes.

- Certified Class IIa medical devices
- Systems with ETL (UL/CSA) certification
- CR series – tested and classified according to the relevant ISO clean room classes

Technological and societal developments and demanding customer requirements continue to present new challenges. Mastering these challenges has helped TBH GmbH to grow steadily. Our certified internal processes will help us to quickly and efficiently find the ideal solution for your requirements.

Tested quality management system in accordance with ISO 9001:2015.

TÜV SÜD ISO 9001

C ETL LISTED US Intertek

LGA CCI - von Kahlden GmbH

TBH Services

The TBH service concept covers a broad range of services which are also locally available through our sales partners in Europe, the USA and Asia.

You can utilise the following services before buying a TBH extraction and filtration system:

- Recording of your process and application conditions
- Configuration of the appropriate extraction and filtration systems
- Creation of system projects and solutions, research into the particular contaminant conditions and development of special concepts
- Comprehensive consultation and on-site training of personnel
- Provision of test systems or trial systems

We will be glad to help you after you have made your purchase.

TBH customer service covers the following areas:

- Prompt delivery of replacement filters from our warehouse, which is guaranteed throughout the service life of your systems
- Warranty period of 24 months, or for the maximum number of operating hours
- Information about new developments and filter technologies is provided on a regular basis
- Invitations to trade fairs and technology days

Upon request, we will offer you:

- Installation, connection and commissioning of your extraction device, including instruction of personnel
- Special startup for extraction systems used in pharmaceutical/clean room applications, incl. IQ (installation qualification), OQ (operational qualification) and filter seal-seat testing
- Maintenance agreements for your systems
- 24-hour repair service
- Replacement unit provided when repair work is being carried out
- Repair and replacement part service, also on site
- Adjustment of your units to changing applications by replacing air intake and filter modules

EFFICIENCY

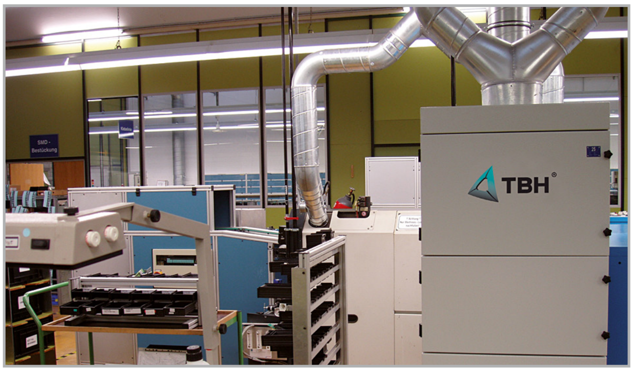
Areas of Expertise

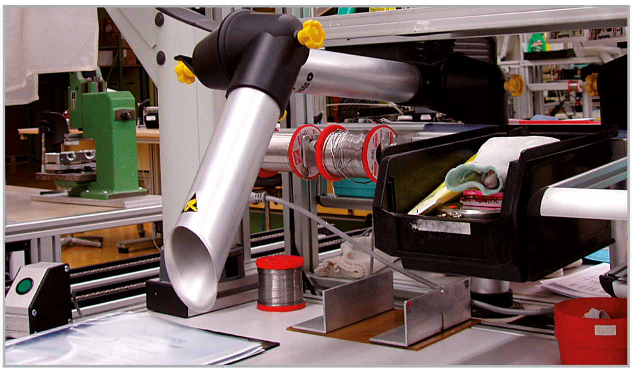
TBH provides energy-efficient, low-maintenance systems for every application – from a cost-efficient small unit, to powerful central extraction solutions. Therefore TBH Exhaust- and Filtration Systems can be found in many industrial areas.

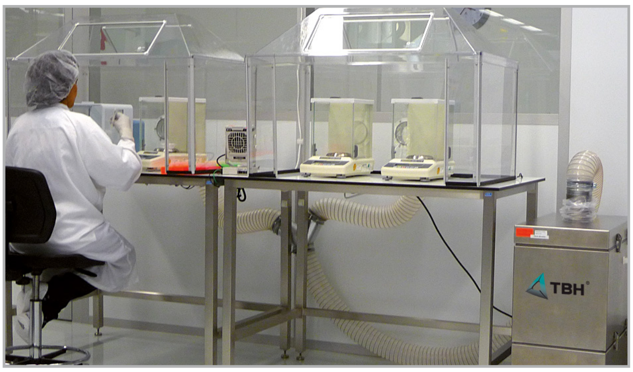
- Laser machining
- Electronics
- Plastics processing
- Metalworking
- Precision mechanics
- Print and paper industry
- Packaging industry
- Restoration
- Dental applications
- Medicines
- Pharmaceutics
- Laboratory areas
- Clean room areas

We design and implement customer-specific solutions for special requirements, which allows for optimal integration of the filter system in existing production processes or during the planning and configuration of new production plants.

Continuous further developments, the use of modern technologies and adjusting to the latest directives and requirements ensure the reliable quality of TBH products.







Applications

The wide range of TBH products offers solutions for most applications. Our modular design, with multiple filters mounted in separate stacked compartments makes TBH extraction and filter systems ideally suited for:

- Dust, both coarse and fine
- Dust and fine dust in cleanrooms
- Dust, laser fumes, laser welding
- Oil mist and oil emulsion mist
- Electrical discharge machining fumes
- Solvent vapours
- Glue fumes
- Solder fumes
- Medical and cosmetic waste products

References

Numerous industrial partners are using our products:

- EADS (Airbus)
- Lufthansa Technik AG
- BOSCH
- Forschungszentrum Karlsruhe
- Fraunhofer Institut
- Karlsruhe Institute of Technology
- SIEMENS
- Henkel
- GETRAG
- Daimler AG

TBH PRINCIPLE

Flexibility through Modularity

The flexible and adjustable TBH unit concept includes powerful fans or blowers, as well as variously equipped filter modules. The modular design allows for simple and fast adjustments to filter combinations or blower capacity, to suit changed operating conditions.

Your benefits:

- Simple filter replacement
- Cost-effective and fast up grading and adjustment
- Individual optimisation options
- Easy replacement of the motor module in case of service
- different connection interfaces for collection units

LN- / GL-Series
Saturation filter systems

1) TBH MultiCover
2) Z-LinepanelPlus filter
3) Particle filter
4) Activated carbon/BAC filter
5) Motor module

TFS-Series
Saturation filter systems

1) SafeLine filter
2) Particle filter
3) Activated carbon/BAC filter
4) Motor module

LN 600-Series
Saturation filter systems

1) Pocket filter
2) Particle filter
3) Activated carbon/BAC filter
4) Motor module

GL DESK-Series
Saturation filter systems

1) Z-LinepanelPlus filter
2) Particle filter
3) Activated carbon/BAC filter
4) Motor module

DT-150
Saturation filter systems

1) moveable safety screen
2) Pre-filter mat
3) Particle filter
4) Activated carbon/BAC filter
5) Motor module

FP 150-Series
Automatic filter cleaning

1) Air inlet
2) Filter housing
3) Dust collector
4) Auto. cleaning
5) Motor module

FP 150-Series
Automatic filter cleaning

1) antistatic filter cartridge
2) Particle filter
3) Activated carbon/BAC filter

FPV 202
Automatic filter cleaning

1) Dust collector
2) antistatic filter cartridge
3) Air inlet
4) INSPIRE control electronics

FP 200-Series
Automatic filter cleaning

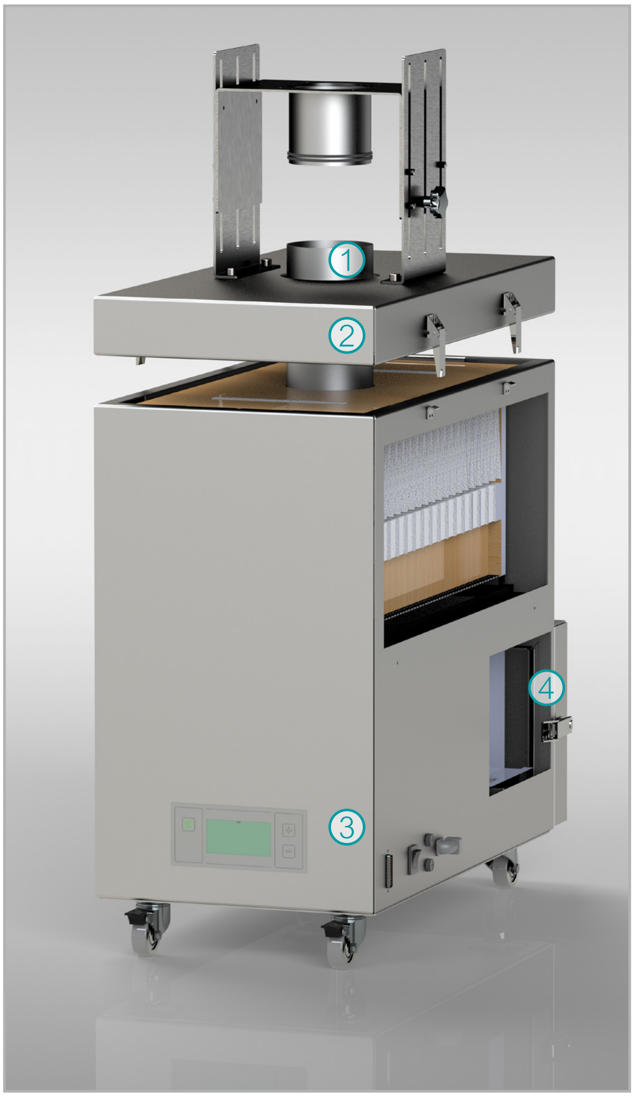
1) Dust collector
2) Particle filter
3) Activated carbon/BAC filter
4) Motor module

TBH Clean Room Technology

The TBH CR series was specially developed for the particular requirements of clean rooms and clean room areas. The different filter configurations in the various air flow categories enable the CR units to be certified for use in clean rooms of the ISO Classes 3, 5, 7 or 9 (depending on type and extension level).

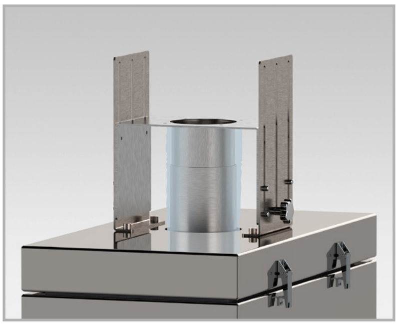
Your benefits:

- Clean-room suitable system design according to ISO class
- Simple, contamination-free filter change by patented technology
- possibilities of process qualification of the system after filter replacement
- Certified according to DIN ISO 14644-1 / EC GMP directive

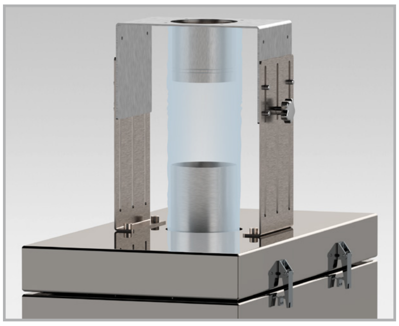


1) Filter module with intake tube and protective hose
2) Removable cover for easier filter replacement
3) police filter
4) Motor module
5) Seal-seat-test of the filter after the filter replacement (see page 17)

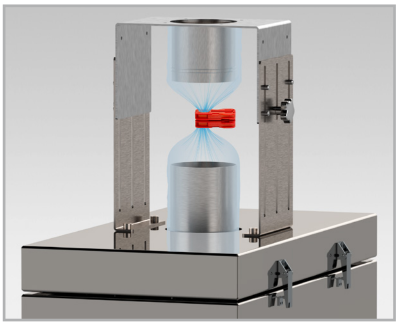
Contamination free undocking procedure



filter module with intake tube and protective hose



undocking of the intake tube, the protective hose expands

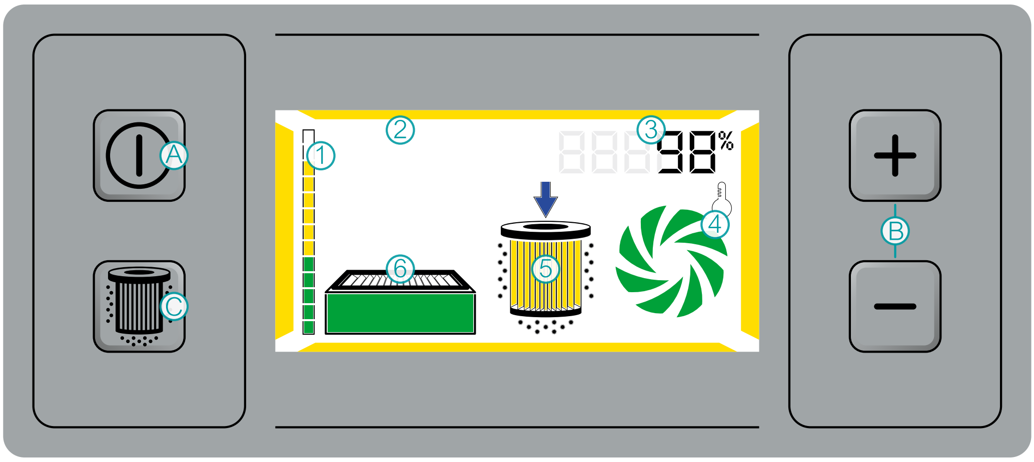


contamination free filter replacement due to sealing of the protective hose using a binder or a heat sealer

Powerful electronics

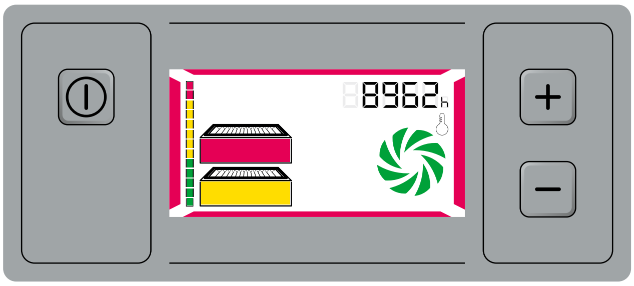
The electronic control system of the INSPIRE generation launched in 2016 is a TBH-own development based on our comprehensive know-how for a further increase of our systems' performance and user-friendliness.

As the most important functions of the extraction and filter system are shown on the new ergonomic colour display, our systems allow straightforward and intuitive operation knowingly abstaining from complicated menu navigation.

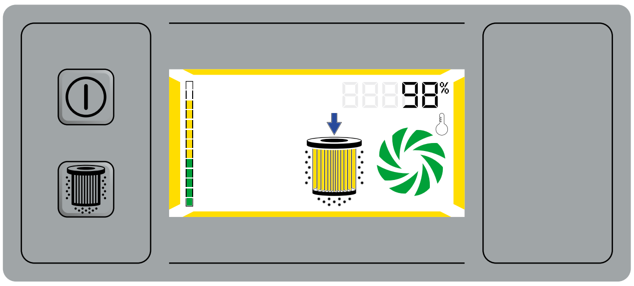


INSPIRE control electronics for FP systems

A) Switching between run/standby
B) Manual adjustment of the rotation speed
C) Manual start of the filter-cartridge cleaning
1) Filter saturation indicator
2) System status indicator
3) Performance-setting indicator / operating-hours meter
4) Temperature and turbine-malfunction indicator
5) Cleaning-in-progress indicator
6) Filter status indicator



INSPIRE control electronics for LN, GL, TFS & BF systems



INSPIRE control electronics for FPV systems

Functions of the INSPIRE control electronics

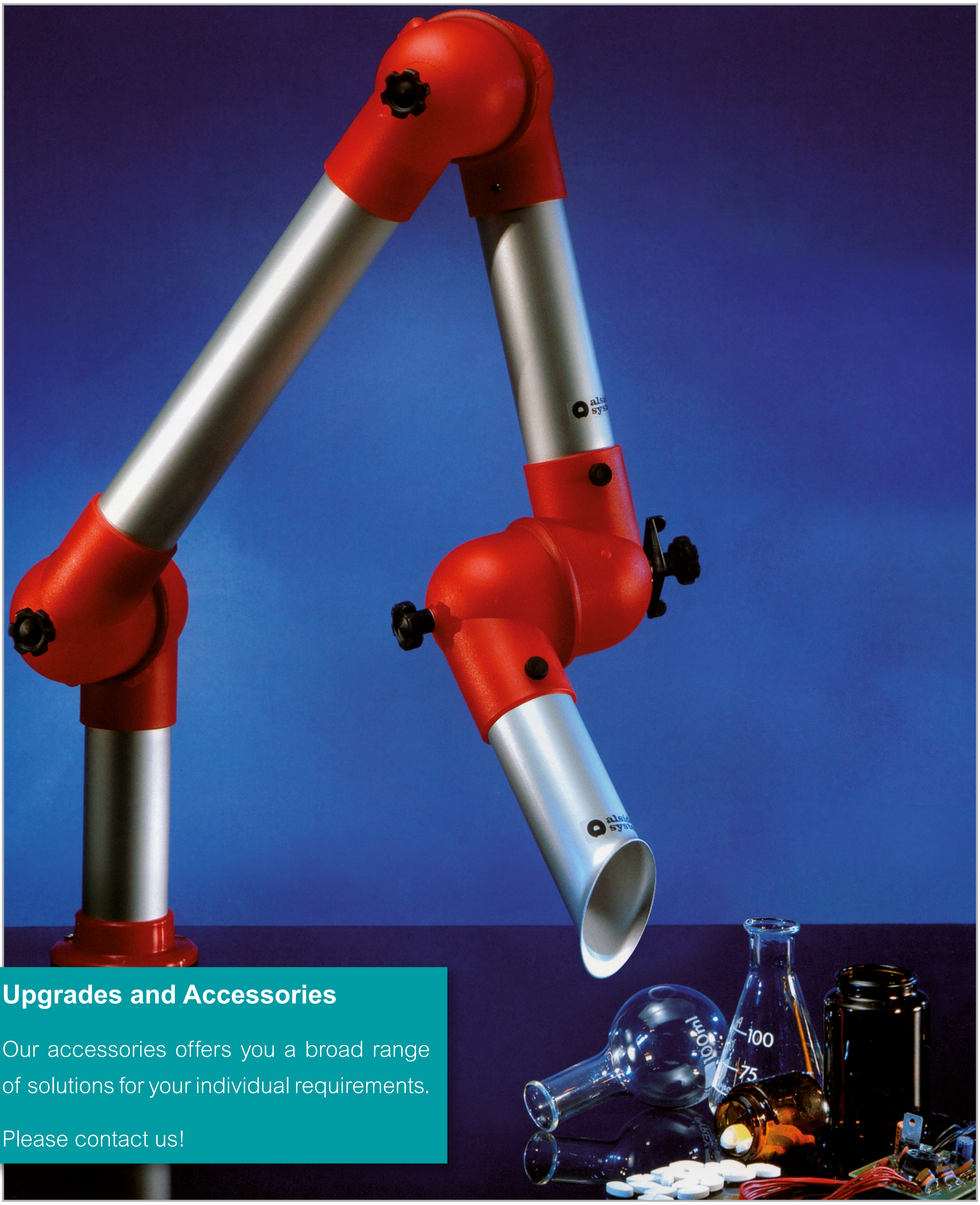
INSPIRE control electronics features a large variety of functions easing the system operation.

Functions of the INSPIRE control electronics by type of system

FUNCTION	BF series	LN 200 series GL series GL / LN series OEN 150 series	TFS series LN 600 series OEN 700 series	FP 150 series FP 200 series	FPV 200 series
Individually adjustable filter cleaning				✓	✓
Parametrization of custom functions		✓	✓	✓	✓
Error memory improves the coordination between the customer and the TBH service		✓	✓	✓	✓
Individual filter monitoring for prefilter and main filter with status indicator			✓		
Common filter monitoring of all filters installed	✓	✓			✓
Filter monitoring for additional (optional) particle filter is possible				✓	
Ergonomic colour display	✓	✓	✓	✓	✓

Interface functions of INSPIRE control electronics by type of system

FUNCTION	BF series	LN 200 series GL series GL / LN series OEN 150 series	TFS series LN 600 series OEN 700 series	FP 150 series FP 200 series	FPV 200 series
Filter full	✓	✓	✓	✓	✓
Run/standby	✓	✓	✓	✓	✓
External adjustment of the rotation speed		✓	✓	✓	✓
Rotation-speed notification		✓	✓	✓	✓
Temperature notification		✓	✓	✓	✓
Collective fault		✓	✓	✓	✓
Filter cleaning control				✓	✓
Parametrization access		✓	✓	✓	✓
Notification memory		✓	✓	✓	✓
Data logger		✓	✓	✓	✓



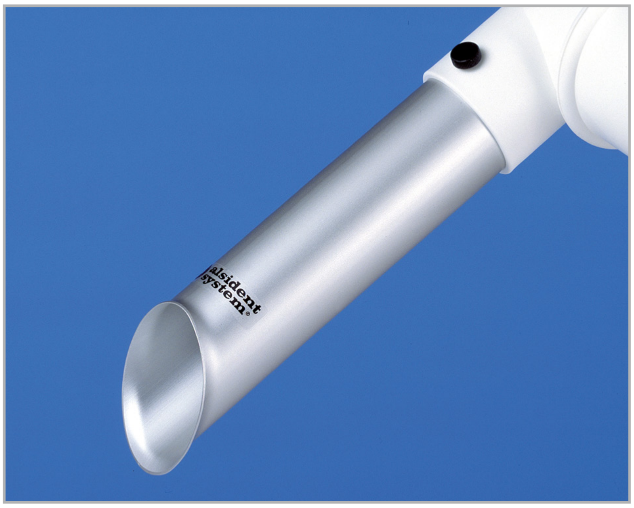
Upgrades and Accessories

Our accessories offers you a broad range of solutions for your individual requirements.

Please contact us!



alsident system

alsident system

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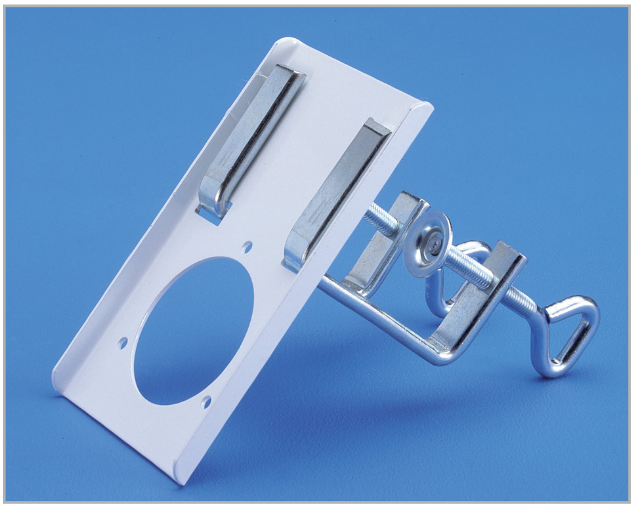
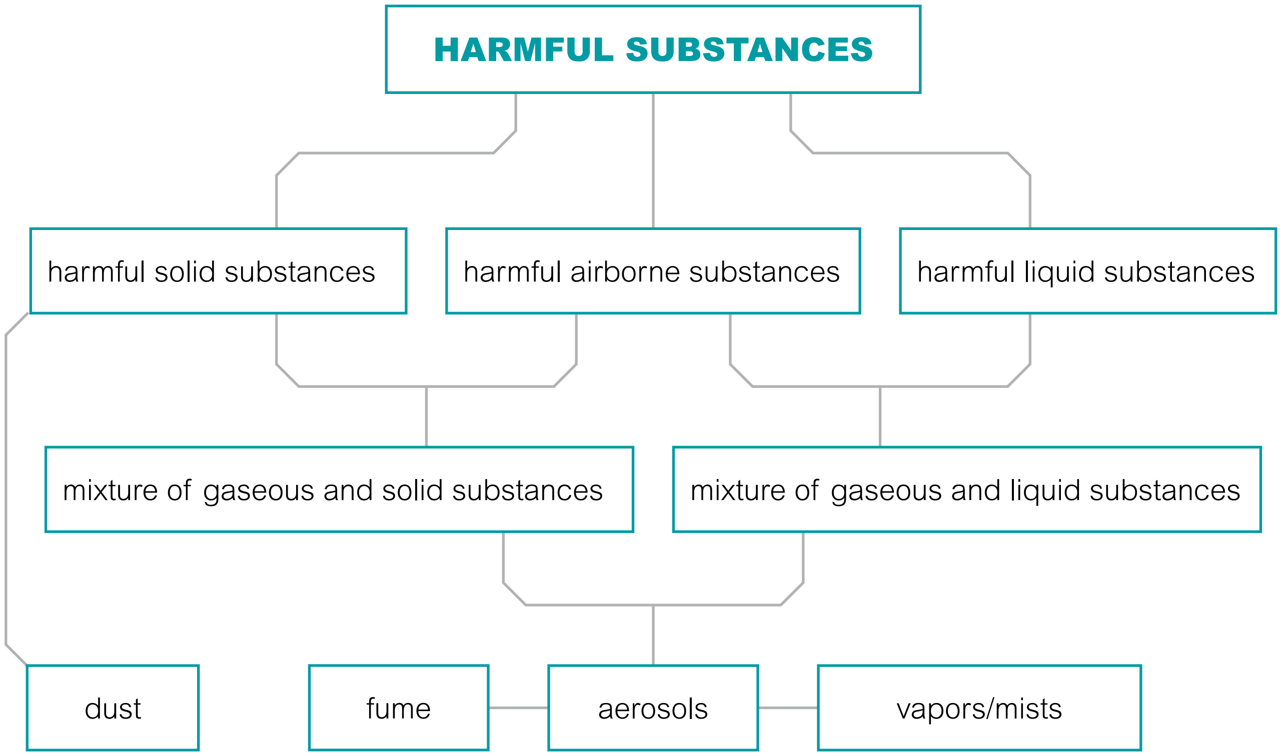


WORTH KNOWING

Harmful Substances

Classification of contaminants, and extraction and filter technology terms

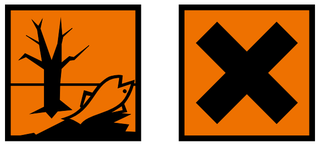
Many different contaminants are released in the workplace through various processes. The following figure provides an overview of contaminant classes:



Liquids and solids can exist as aerosols, or droplets and particles so small they float in the air. These are often referred to as vapours, mists or smoke. Particles and droplets can take hours to settle and while airborne are particularly dangerous for people, machinery and the environment.

They can be distributed over a wide area and even spread their harmful effects far away from the production site.

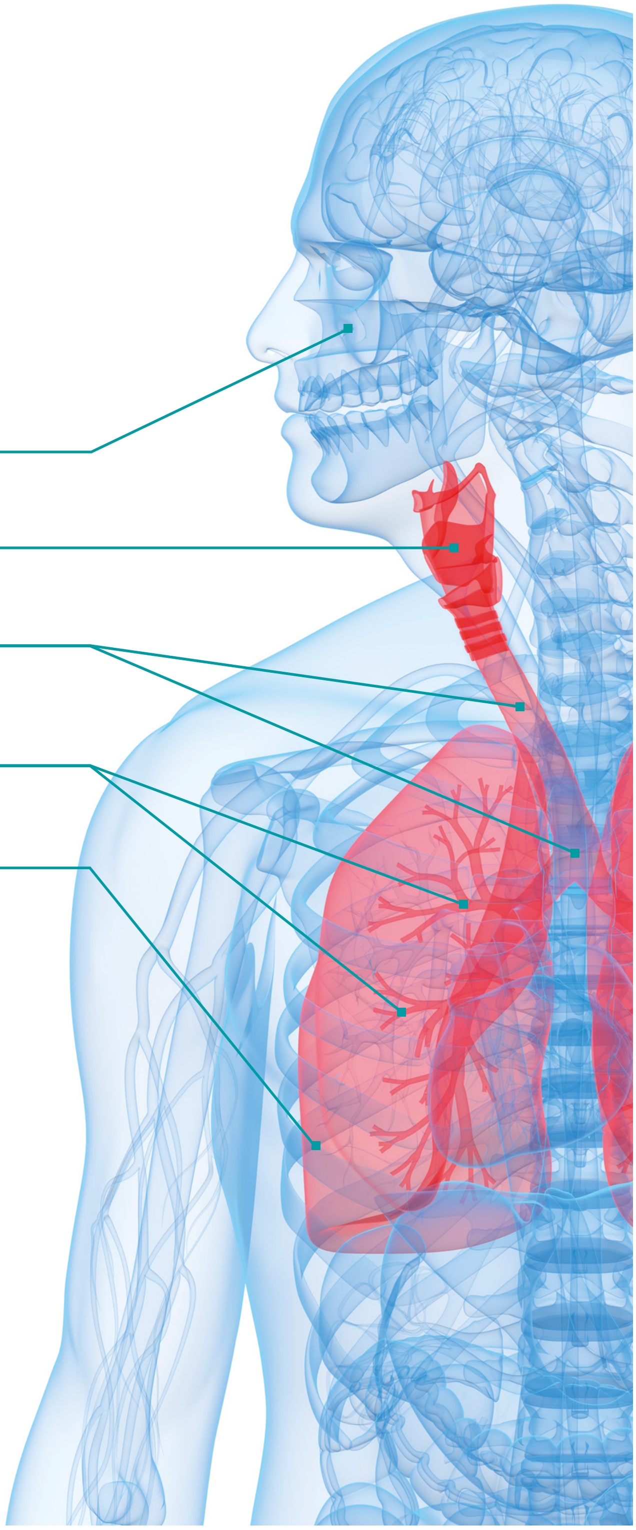
Dust, smoke, mist or gases and vapours are released during many work processes. These substances have been shown to impact work performance and health.



Health effects

Possible health consequences include:

- Inflammations and tissue changes in the breathing organs
- Asthma, allergies, functional disorders of the lungs
- Deterioration of the lung’s ability to clean itself, lung cancer

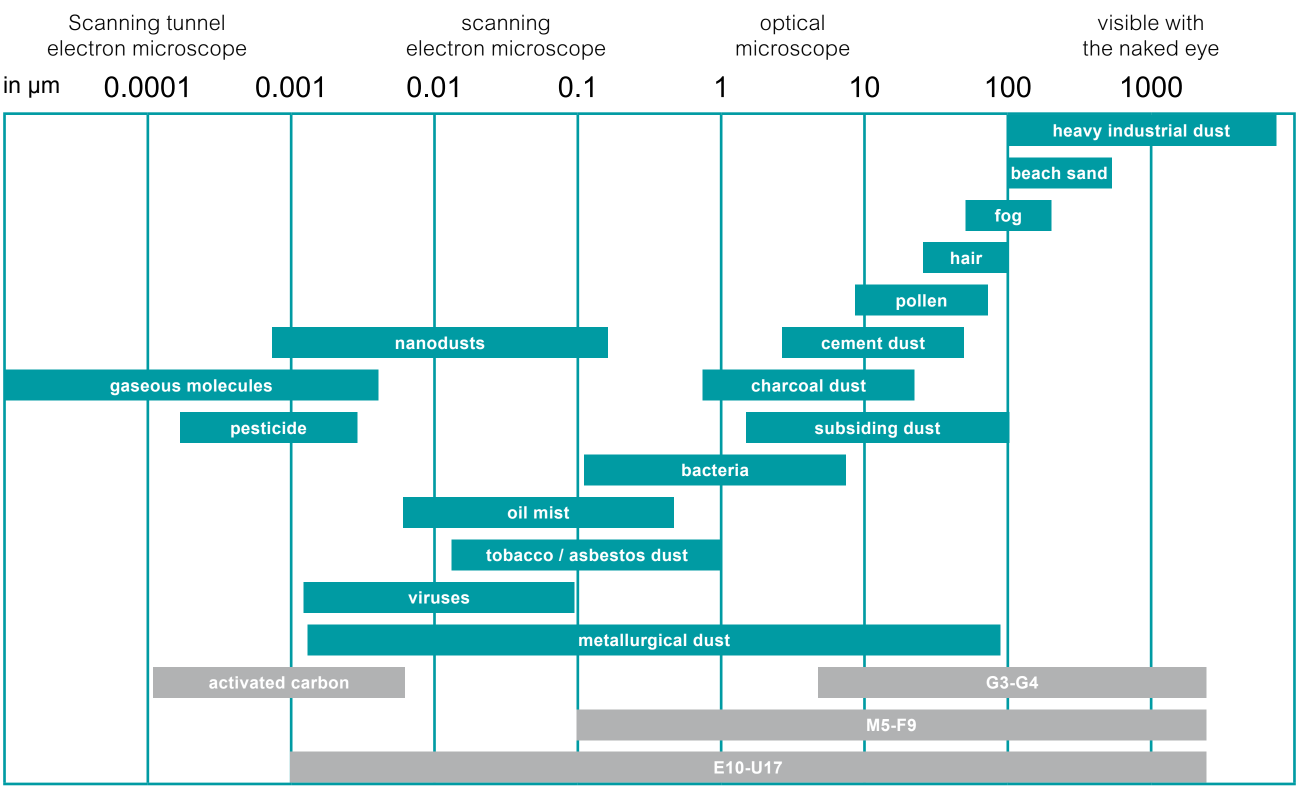



healthy lungs

damaged lung (without filtration system)

Particle

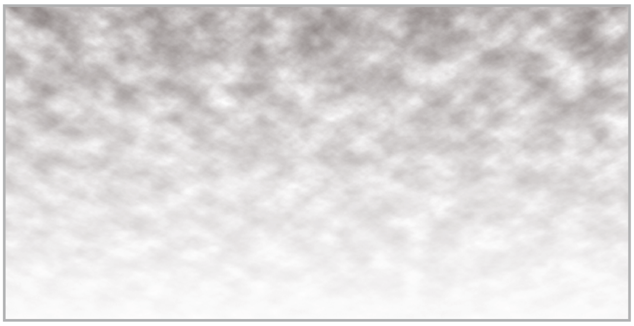
Examples of particle sizes



Falling particles

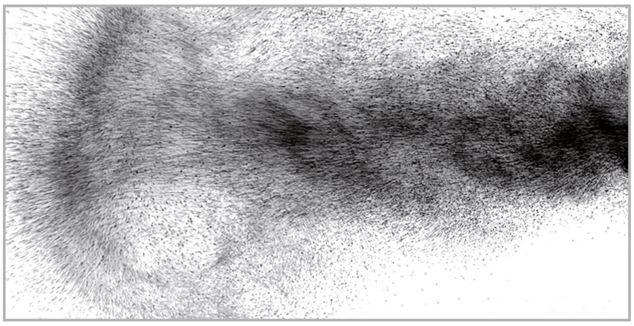
Coarse particles measuring between 1 mm and 0.1 mm (= 100 µm) can still be seen with the naked eye. Examples of these include heavy industrial dust, sand, mist and fibres. Smaller particles measuring less than 100 µm can only be seen with a microscope. Examples of these include pollen, cement dust, coal dust, coarse metallurgical dust or general falling dust particles that are larger than 1 µm.

The particle sizes correspond to filter classes G3-G4, but they are also trapped by the much finer filter classes M5-F9 and E10-U17.



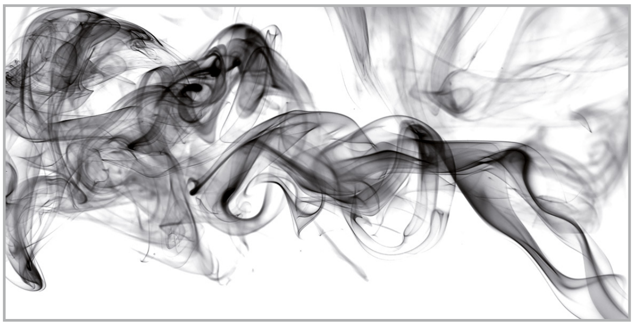
Particulate matter

Particles which never fall and are always in the air are smaller than 1 µm. Some bacteria are smaller than 1 µm, but the main representatives of this category are metallurgical dust and oil mist. Particles that are larger than 0.1 µm and smaller than 1 µm are covered by the filters in classes M5-F9, but the E10-U17 classes also catch these particles.



Ultrafine particles

Particles that are smaller than 0.1 µm can only be seen with a scanning electron microscope. Fine oil mist particles measure between 0.01 µm and 0.1 µm. Some tobacco smoke and asbestos particles are even smaller than 0.01 µm. Most viruses and extremely fine nanodust measure between 0.001 µm and 0.1 µm. Only EPA, HEPA and ULPA filters in classes E10-U17 can filter these particles. Some of the particles that are smaller than 0.01 µm are already filtered by activated carbon.

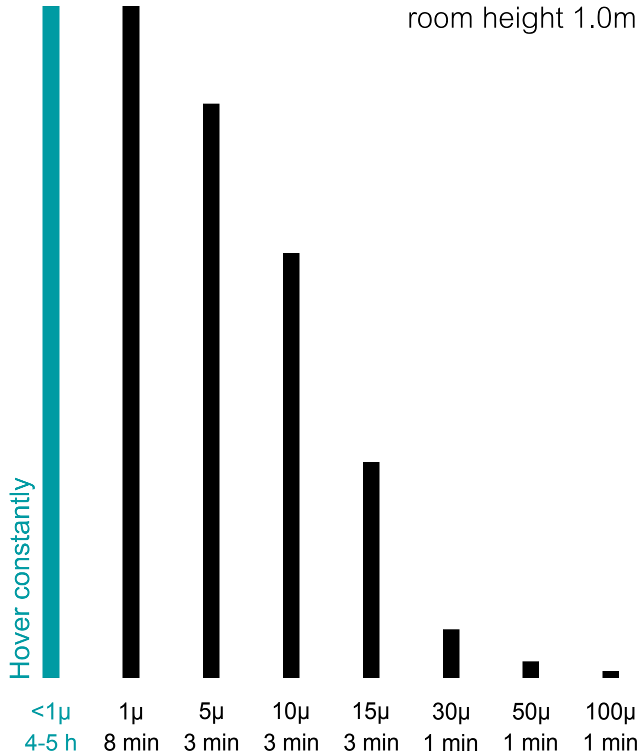


Gaseous contaminants

Gas molecules and pesticides are rarely larger than 0.001 µm and activated carbon is the only filter medium for particles this small. They are carried by the air and can penetrate as far as the pulmonary alveoli when a breath is taken. Apart from the amount of contaminants, the particle size distribution and the operating conditions, there are other factors which can influence filter selection decisions. It is therefore essential to have professional advice and possibly an on-site assessment so that you can profit from the experience of a global company like TBH GmbH.

Settling times

The weight and size of a particle is of particular importance for its settling time. The smaller and lighter the particles, the greater the possibility that they will remain floating in the air helped by thermal currents and vortices. The following figure shows how long particles float in the air before they settle. The settling times apply for droplets or particles at a height of one metre.



Particulate matter is a health risk

The finer the particles, the greater the health risk that they pose. It is important to note that the chemical composition of fine dust is not the only decisive factor in assessing the health risk, because even chemically non-toxic particles can also penetrate deep into the respiratory tract, and some particles may even reach the pulmonary alveoli.

Fine dust is believed to be cancer-causing, even without having an immediate toxic effect. A great load is placed on the bronchial area and lungs, if the respiratory tracts or the pulmonary alveoli are blocked by fine dust particles. Depending on the application, ultra-fine particles can impact the health of employees and even the product quality.

Harmful ultra-fine particles remain in the air that we breathe for a particularly long time

Particles with a size of 15 µm settle within one minute, unless they are moved by air currents. Settling can take longer in higher areas. The settling time is 3 minutes for particles with a diameter of 10 µm, and 8 minutes for particles with a diameter of 5 µm. Since settling times do not increase in a linear fashion, particles with a diameter of 1 µm need 4 to 5 hours to settle. Even smaller particles remain suspended and never settle. This means that ultra-fine particles which are particularly harmful to health also remain for the longest period of time in the air, where they can be inhaled.

Coarse dirt harms people and damages machinery

While fine particles remaining in the air for a particularly long time are a health hazard, coarse particles settle quickly and contaminate surfaces, machine parts and the interior of the machine (if accessible). When the air moves, the particles can be distributed over a wide area and inhaled, which places an additional burden on the respiratory tract.

Filter types and filter classes

In practice, there are a number of different terms that are used for filter types. Table provides an overview of the main groups, filter designations and filter classes.

Pre-filter	
Coarse dust filter Filter classes G1-G4	Fine dust filter Filter classes M5-F9
Saturation filter	

Particle filter *(particulate matter filter)*	
Filter classes E10-E11 *(EPA)*	Filter classes H13-H14 *(HEPA)* Filter classes U15-U17 *(ULPA)*
Cleanable filter	**Saturation filter**

Molecular filter	
Physical adsorption filter *(activated carbon)*	Chemical adsorption filter
Saturation filter	

Saturation filters (not cleanable)

These collect particles on the fibres of the filter media, leaving apertures for the air to pass easily. When particles block the apertures between the fibres at the air exit side of the media, the pressure loss through the media increases and the flow starts to fall, requiring the replacement of the saturated filter.

Cleanable filters

Some filter designs allow the filtration media to be cleaned to restore the normal airflow. Cleaning is carried out using compressed air or a mechanical technique (vibration, shaking, wiping off). The most common types are bag filters, filter cartridges or sintered plastic or ceramic filters, most of which are only used for dry dust.

Pre-filters and particle filters

In Europe, standard EN 779 is almost exclusively used to classify coarse and fine dust filters (= particulate matter filters). EPA, HEPA and ULPA filters, particularly fine-pored particulate matter filters, are rated in accordance with standard EN 1822. Depending on the standard, either the initial separation efficiency or the fractional separation efficiency is used as the performance criterion for standard contamination. In addition, we are currently planning to implement ISO 16890 meant to replace EN779 in 2018.

The initial separation efficiency is the separation efficiency of the new filter, i.e. the relationship between the collected material and the supplied material. The fractional separation efficiency denotes the separation efficiency of a filter with regard to a fraction, meaning particles of a specific size class. The following table shows the usual standards and the corresponding classifications.

ACTUAL STANDARDS				RELATED OR OTHER STANDARDS	
ISO 29463-1	**EN 1822**	**DIN EN 779**	**ISO 16890**	**US MIL-STD**	**DIN EN 60335**
EPA, HEPA, ULPA (substitutes DIN EN 1822)	**EPA, HEPA, ULPA** initial arrestance **A** **DEHS, MPPS** **approx 0.1-0.3 µm**	**fine dust filter** average efficiency **A** **0,4 µm** final pressure difference **450 Pa**	**fine dust filter** average efficiency (substitutes DIN EN 779) **0.3-10 µm**	**particle filter** initial arrestance **A** **DOP 0.3 µm**	**particle filter** passing rate **D** **paraffin oil** **61% < 1 µm**
	A (integral)> 85 % **E10**	E>40% **M5**	**ISO ePM$_{10}$** > 50%	95%	D < 1% **L**
A (integral) ≥ 95% **ISO 15 E** A (integral) ≥ 99% **ISO 20 E**	A (integral)> 95 % **E11**	E>60% **M6**	**ISO ePM$_{2,5}$** 50-65% **ISO ePM$_{10}$** > 60%	99.97%	D < 0.1% **M**
A (integral) ≥ 99.5% **ISO 25 E** A (integral) ≥ 99.9% **ISO 30 E**	A (integral)> 99.5 % **E12**	E>80% **F7**	**ISO ePM$_{1}$** 50-65% **ISO ePM$_{2,5}$** 65-80% **ISO ePM$_{10}$** > 85%	99.99%	D < 0.005% **H**
A (integral) ≥ 99.95% **ISO 35 H** A (integral) ≥ 99.99% **ISO 40 H**	A (integral)> 99.95 % **H13** A (lokal)> 99.75 %	E>90% **F8**	**ISO ePM$_{1}$** 65-80% **ISO ePM$_{2,5}$** > 80% **ISO ePM$_{10}$** > 90%	99.999%	
A (integral) ≥ 99.995% **ISO 45 H** A (integral) ≥ 99.999% **ISO 50 U**	A (integral)> 99.995 % **H14** A (lokal)> 99.975 %	E>95% **F9**	**ISO ePM$_{1}$** > 80% **ISO ePM$_{2,5}$** > 95% **ISO ePM$_{10}$** > 95%		
A (integral) ≥ 99.9995% **ISO 55 U** A (integral) ≥ 99.9999% **ISO 60 U**	A (integral)> 99.9995 % **U15** A (lokal)> 99.9975 %				
A (integral) ≥ 99.99995% **ISO 65 U** A (integral) ≥ 99.99999% **ISO 70 U**	A (integral)> 99.99995 % **U16** A (lokal)> 99.99975 %				
A (integral) ≥ 99.999995% **ISO 75 U**	A (integral)> 99.999995 % **U17** A (lokal)> 99.9999%				

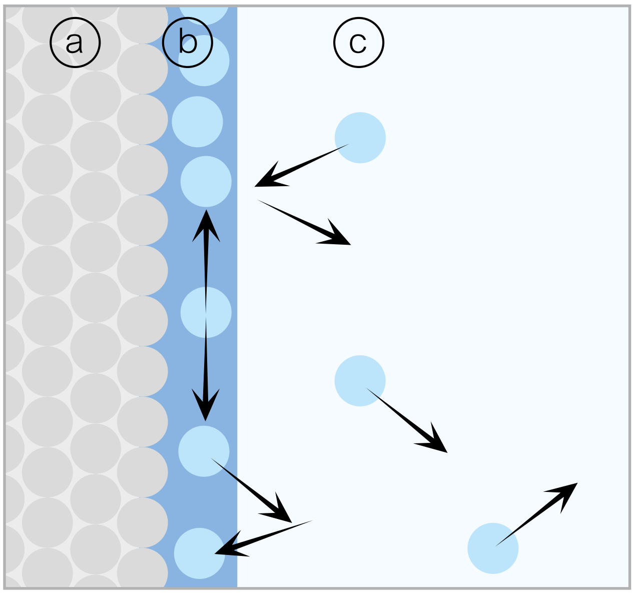
Adsorption filter

Physical adsorption

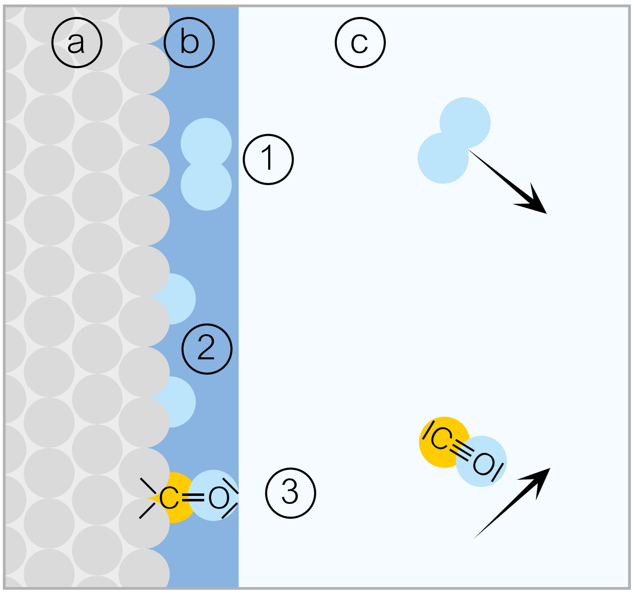
Generally speaking, adsorption is a physical process in which molecules of a gas or vapour substances adhere to the surface of a different substance and concentrate there. Activated carbon is a common filter medium that can adsorb and store gas and vapour molecules on the large extended surface area of it's microstructure. For this reason, activated carbon is often used to collect unpleasant odours or noxious gases. Activated carbon is produced from organic substances such as coal, wood, peat and coconut shells. Due to it's ultra-fine pores and capillary systems, the adsorbent surface can be as much as 1,700 m² per gramme of activated carbon. This produces an excellent separation efficiency and a large storage capacity, which leads to long service lives.

Chemical adsorption

In contrast to physical adsorption, gas molecules are not collected in the case of chemical adsorption. They are instead broken down and neutralised by a chemical reaction. The neutralisation is achieved through the chemical binding with the reaction substance that is deposited on the carrier material. The molecules that are broken down through this process can then be collected by a physical adsorption filter such as activated carbon. Since physical and chemical adsorption complement one another, a combination of both can filter a wide range of gaseous substances and odours. For this reason, TBH also uses both materials in the form of activated carbon and chemisorbent material in its molecular filters.



a) adsorbent, b) adsorbed at the surface, c) gas phase or solution with adsorbate



a) adsorbent, b) adsorbate, c) gas phase adsorbate, 1) physisorption, 2) dissociative chemisorption, 3) directed chemisorption

Clean room classes and standards

Assessment of air quality using international standards

Clean rooms are defined using ISO clean room classes. ISO 14644-1 stipulates how many particles of which size may be present in one cubic metre of air. The maximum permissible concentrations for the respective classes must not be exceeded. The ISO class with the most stringent requirements for air purity is Class 1, while Class 9 has the lowest requirements. In some cases (especially in the fields of food technology and pharmaceuticals), the air purity is judged by the number of microorganisms or germs (colony-forming units). Annex 1 of the EC-GMP is used in pharmaceutics.

Standardised measuring techniques are used to control the particle or germ concentrations to determine clean room classes. This allows for classification of air quality and establishment of a standardised measurement.

ROOM CLASSIFICATION	DIN EN ISO 14644-1						EG-GMP		REVOKED / OLD STANDARD	
	Cn = max count of particles per cubic meter and particle diameter						Room clas-sification	colony forming units KBE/m²	US FEDERAL STANDARD 209E	
	0.1 µm/m³	0.2 µm/m³	0.3 µm/m³	0.5 µm/m³	1.0 µm/m³	5.0 µm/m³			English Unit ft³	Metric SI Unit m³
ISO 1	10	2								
ISO 2	100	24	10	4						
ISO 3	1000	237	102	35	8				1	M 1.5
ISO 4	10000	2370	1020	352	83				10	M 2.5
ISO 5	100000	23700	10200	3520	832	29	A / B	< 1	100	M 3.5
ISO 6	1000000	237000	102000	35200	8320	293	(B)	10	1000	M 4.5
ISO 7				352000	83200	2930	C	100	10000	M 5.5
ISO 8				3520000	832000	29300	(C) / D /E / F	200	100000	M 6.5
ISO 9				35200000	8320000	293000	with employees			

The following table shows the ISO clean room classes of the EC-GMP with regard to the number of germs and the previously used US Federal Standard 209E, which has been invalid since 2001.

ATEX explosion protection standards

ATEX is a widely used synonym for the ATEX guidelines for the European Union. The term ATEX is an abbreviation of "ATmosphère EXplosible" (French). This directive currently includes two guidelines for the field of explosion protection, the ATEX product guideline 2014/34/EU and the ATEX operating guideline 1999/92/EG.

These guidelines regulate protection against hazards which are caused by the presence of an explosive atmosphere. An explosive atmosphere is defined as a mixture of air and combustible substances (in the form of gases, vapours, mist or dust) under atmospheric conditions in which the combustion process is transferred to the entire unburnt mixture after it has been ignited.

ATEX product guideline 2014/34/EU

The following table shows the classification of products according to ATEX product guideline 2014/34/EU:

EQUIPMENT GROUP II

DEVICES THAT ARE USED IN THE REMAINING POTENTIALLY EXPLOSIVE AREAS					
Category 1		Category 2		Category 3	
continuous, frequent or over longer periods		occasionally		Infrequent and brief	
very high level of safety		high level of safety		normal level of safety	
Zone 0	Zone 20	Zone 1	Zone 21	Zone 2	Zone 22
G	D	G	D	G	D

G = gas, D = dust

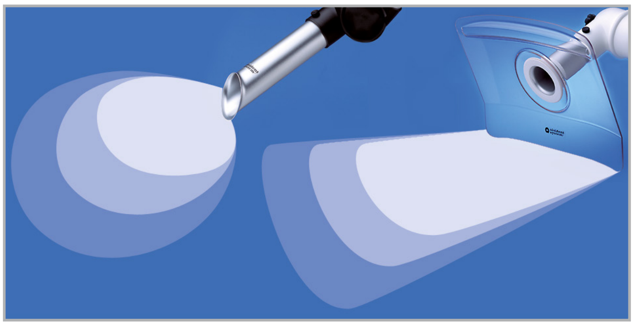
ATEX operating guideline 1999/92/EG

The ATEX operating guidelines divides potentially explosive areas into what are known as zones. In the scope of risk assessment, every employer must create an explosion protection document for the relevant work stations and define the respective zones accordingly.

In order to be able to provide our customers with suitable extraction and filter systems even for critical applications, we also offer systems for explosion-protected areas (mining excluded). The units comply with the current ATEX product guideline 2014/34/EU and with the DIN EN 11127-1:2007 standard. Devices of specific categories must only be used in these specific zones. Use of category 2 devices, for instance, is only allowed for zone 1 (gases or vapours) or zone 21 (dust). FP-series systems are labelled EX II 2/- Dc IIIC T100°C (zone 21) whereas DT-series systems are labelled EX II 3GD (Gc/Dc) EX IIA T4 / IIIB T120°C (zone 2/22).

CLASSIFICATION OF HAZARDOUS AREAS			
gas	**Zone 0** is an area where a dangerous, explosive atmosphere as a mixture of air and combustible gases, vapours or mist exists continuously over longer periods or frequently.	**Zone 1** is an area where a dangerous, explosive atmosphere as a mixture of combustible gases, vapours or mist can occasionally form during normal operation.	**Zone 2** is an area where a dangerous, explosive atmosphere as a mixture of combustible gases, vapours or mist is usually not present during normal operation, or only for brief periods of time.
dust	**Zone 20** is an area where a dangerous, explosive atmosphere in the form of a cloud of combustible dust that is present in the air exists continuously, over longer periods or frequently.	**Zone 21** is an area where a dangerous, explosive atmosphere in the form of a cloud of combustible dust that is present in the air can occasionally form during normal operation.	**Zone 22** is an area where a dangerous, explosive atmosphere in the form of a cloud of combustible dust that is present in the air is usually not present during normal operation, or only for brief periods of time.

System planning



Principles for planning and designing extraction and filter systems

The right design for collecting the contaminants is one of the most decisive factors for cost-effective, suitable dimensioning of the overall extraction and filter system. The job of the collection unit is to collect solid and gaseous contaminants using the air current that is generated by the system. The air speed that is required to do this depends on the size and weight of the particles, as well as the distance from the point of origin and the design of the extraction chamber.

When the collection unit is too far away from the source of the contaminants, the air speed slows down and collection is less effective. Already in a distance of one tube diameter to the source of contaminants, the airflow is down to **7.5%** of the air flow measured in the extraction tube.

Correct placement of the collection element is therefore critical. Past experience has shown that common constructions, such as mounting a suction pipe above the work station, are not sufficiently effective. Laminar currents generally lose less force, because reverse currents and crossflows greatly reduce the effectiveness of suction. Turbulences can be caused by movement in the ambient air, but uncontrolled air turbulences also form at the edges of the collection element. The collection depth is therefore improved by using flanges on the suction pipe or suction hose as seen in the figure. Another measure is to shield the suction point from external disturbing currents.

Additional design considerations concern the integration of the overall system into the workplace. An especially important factor is the mobility of the employees, who should not be obstructed or limited in their range of movement.

The combination of requirements from fluid mechanics and practical conditions result in some standard solution concepts that can be used as a model for effective, suitable dust collection.

Open designs (a) are often very susceptible to disturbing currents. When the ambient air is calm, fresh air flowing in from the side prevents the contaminant-laden air from escaping. In many cases, this concept is sufficiently effective. However, the required air speeds at the source of the contaminants must be maintained.

By installing the collection unit upon the same surface (e.g. table) as the emission source (b), the **Coandă effect** can additionally be used. This effect describes the tendency of the air flow produced by the extraction system to attach to the surface, thereby reducing turbulences and crossflow and increasing the effectiveness of suction. In contrast, if the collection unit is installed above the emission source, the air flow is unguided and more turbulent, thereby reducing the effectiveness of suction. The discharge impulse from rotating tools can also be used.

a

b

(c)

(d)

Shielding on the sides (c) prevents the contaminant-laden air from escaping. A system that is closed on all sides (d) and no longer accessible from outside, ensuring that all of the contaminants are collected. The applicability depends heavily on the usage conditions.

Air speeds in the collection element

In order to collect any solid or gaseous contaminants, specific air speeds are required, which depend on the size and weight of the particles.

REQUIRED AIR SPEED			
at the entrance of the extraction pipe/hose		in the area of origin for certain processes	
industrial dust:	≥ 20 m/s	vapours	0.1 – 0.2 m/s
fine dust/smoke	14-18 m/s	soldering fume	0.2 – 0.3 m/s
gas molecules	≥ 10 m/s	laser fume	0.2 – 0.4 m/s
		welding fumes	0.3 – 0.5 m/s
		grinding	0.3 – 1.0 m/s

Depending on the size of the collection unit (extraction tube), the required effective air flow rate of the system can be calculated approximately using the following simplified formula:

$$V = A \cdot c$$

V: Effective air flow rate V [m³/h];
A: Area of the extractionpipe A [m²];
c: Air speed [m/s]

We can see from this basic formula that the effective air flow rate of the system must increase as the diameter of the extraction hose increases.

On the other hand, the required effective air flow rate impacts the filter area, which in turn affects the size of the system, and also its price. When selecting and designing the collection unit, you should therefore choose the smallest possible diameter, which results from the required air speed.

The following table demonstrates the interdependency between the extraction hose/tube and the effective airflow needed to achieve the required airspeed for a propper collection of all particles.

Extraction tube/ hose diameter (mm)	Industrial dust > 20m/s	Fine dust/fume 16m/s	Gas molecules > 10m/s
50	140 m³/h	115 m³/h	70 m³/h
63	225 m³/h	180 m³/h	110 m³/h
80	360 m³/h	290 m³/h	180 m³/h
100	565 m³/h	450 m³/h	280 m³/h
125	880 m³/h	710 m³/h	440 m³/h
160	1450 m³/h	1160 m³/h	720 m³/h
200	2260 m³/h	1810 m³/h	1130 m³/h
250	3530 m³/h	2830 m³/h	1770 m³/h

For the adjoining tube diameters the recommendet air flows should not be under-run.

Example calculation:
Fine dust is to be extracted using a pipe diameter of 80 mm. This results in a target value for the air speed of

$$c_{target} = 15 \text{ m/s}$$

The cross-sectional area of the extraction pipe results from:

$$A = \frac{d^2 \cdot \pi}{4} = (0.08\text{m})^2 \cdot 3.14 / 4 = 0.005\text{m}^2$$

$$V = A \cdot c = 0.005 \text{ m}^2 \cdot 15 \text{ m/s} = 0.075 \text{ m}^3\text{/s}$$

Multiply by 3,600 s/h to convert this value to the more common unit of m³/h:

$$V = A \cdot c = 0.075 \text{ m}^3\text{/s} \cdot 3{,}600 \text{ s/h} = 271 \text{ m}^3\text{/h}$$

Result: The extraction system must provide an effective air flow rate of at least 270 m³/h in order to reach the required speed of 15 m/s.

In summary, the following points should be considered with regard to dust collection

- Extraction should be carried out as close as possible to the point of origin, because the air speed drops significantly even a short distance away from the point of collection
- Minimise air crossflows
- If possible, point the suction opening towards the flight of the shavings/dust
- Connect the collection elements as close to the tool as possible and cover it as much as possible
- Use air deflectors to redirect the circulation current around rotating tools towards the suction pipe
- Use the smallest possible suction pipe diameter to keep the required power of the system as low as possible

Operating point and effective air flow of the overall extraction and filter system

Differences in blowers / radial fans / fans

The performance of an extraction and filter system is mainly dependent on the motor. Various technologies with different power factors are available. Blowers and various types of radial fans can reach similar air flow rates, but differentiate in other important aspects. The following table shows these differences and the field of application. All values shown are average values and are used to show the most important technical features.

TECHNICAL DATA	BLOWER	RADIAL FAN	REGULATED FAN	UNREGULATED FAN
Max. rpm	25 000	8 000	8 000	2 800
Max. static pressure	15 000 - 20 000 Pa	6 000 Pa	5 500 Pa	1 500 - 2 000 Pa
Garanteed operating hours	Brush motor 600h Brushless motor 5 000h	Brushless motor 10 000h	Brushless motor 10 000h	Brushless motor 10 000h
Expected operating hours	20 000h	40 000h	20 000h	15 000h
Noise Level	< 60 dB (A)	< 53 dB (A)	< 63 dB (A)	< 74 dB (A)
Motor Power	1-2 kW	0.2-0.7 kW	2.0-2.9 kW	0.3-7.0 kW
Minimum Tube diameter	32 mm	80 mm	160 mm	160 mm
TBH Product Series	LN 230-265, 615; FP 150, 213; OEN 150, 155; BF 9, 100/200, 1000/1200	GL DESK 20-30; GL 230-265; BF 5, 10	LN 610; OEN 710; FP 211	Special solutions

Static pressure is an important motor parameter. Static pressure describes the force that is required to overcome air resistance. The tube/hose diameters that are to be used are determined by the type of collection unit and the air speeds that are needed to collect the particles. Air flow rate and pressure losses within the system are interrelated, as explained in the next section.

Characteristic curve for fans and operating point

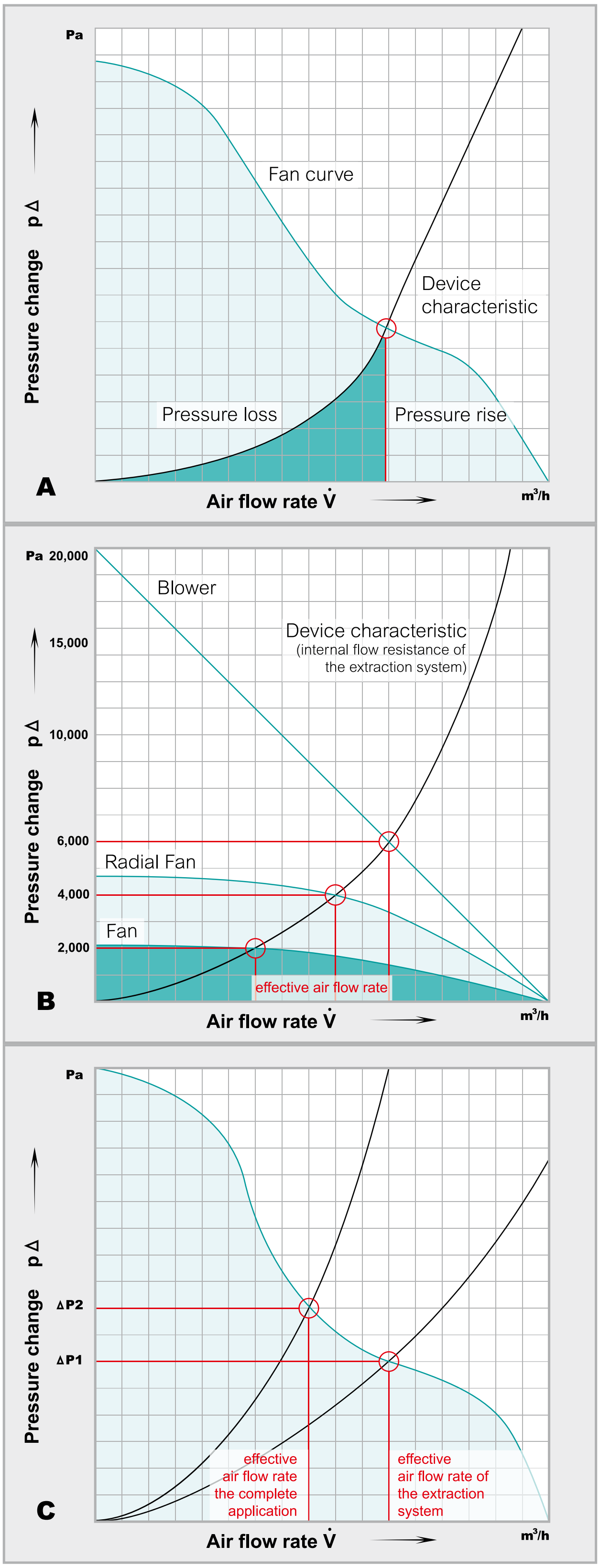
When a fan is set up and operated, it produces a large air flow rate (freestanding). But if the fan is connected to a system or inside a device, the additional flow resistances (filters, air diverters) must also be overcome.To do so, the fan must exert a certain amount of overpressure, which is referred to as pressure rise and which causes the air flow rate to drop. The characteristic curve (figure A page 38) for fans describes the interdependence between the flow rate and the pressure rise.The intersection between the fan curve and the device characteristic (internal flow resistance of the extraction system) shows the effective airflow of the extraction system. Many manufacturers of extraction and filtration systems only provide the freestanding airflow rate, which is actually much higher than the effective airflow rate of the filter system.

The figure (B) compares the different motor technologies at the same freestanding airflow. This clearly shows the impact of different motor technologies on the effective airflow of an extraction and filtration system. To avoid planning errors you should always ask for the effective airflow rate of the extraction and filtration system.

If this isn't taken into account, the price/performance ratio of different manufacturers cannot be truly compared, which leads to the earlier mentioned planning errors.

Pressure losses within the intake piping and the collection devices must be taken into account for a complete extraction and filter system. These are essentially caused by the length and diameter of the suction pipe and collection unit.

The system's actual operating point (C) can ultimately be determined by the combination of all pressure rises and pressure losses. This is then used to determine the air speed needed to collect the solid and gaseous contaminants.



Do you have any remaining questions? Please contact us! We are looking forward to use our wide product range, knowledge in filter technology and our experience in the field of extraction systems to provide you with the best solution to your problem.

Composed based on our own experience and the following references:

Technology:

- Recknagel, Sprenger, Schramek - Taschenbuch für Heizung + Klimatechnik
- Winfried Gräf - Maschinensicherheit
- Klaus Wettingfeld - Explosionsschutz nach DIN VDE 0165 und Betriebsicherheitsverordnung.
- Labastille, Reimar, Warner - EMV nach VDE 0875
- Generelle Informationen der Fa. Lindab über die Auslegung von Lüftungsanlagen (Angaben aus dem Katalog).
- P. Heyder, D. Lenzkes, S. Rudnik - Elektrische Ausrüstung von Maschinen und maschinellen Anlagen

Filtration Technology:

- Lothar Gail, Hans-Peter Hortig - Reinraumtechnik
- Luftfilterbau und Vertriebs GmbH - Grundlagen der Filtertechnik

Standards:

DIN EN 779

DIN EN 1822

DIN EN 60601-1

DIN EN 61241-0

VDI 2083

DIN EN ISO 14971

DIN EN 60204

DIN EN 61000

DIN EN ISO 14121-1

DIN EN 1127-1

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