Air filtration

system for data centres

Innovative air filtration, tailored for the needs of critical data centre environments.

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Air filtration
for data centres

Data centres need stable air quality to ensure that sensitive electronic components work reliably. Fine dust increases the pressure drop on heat exchangers and prevents heat from dissipating. Corrosive gases can damage printed circuit boards, terminals and mechanical parts, which is why we recommend multi-stage filter systems to deal with particulate matter as well as, where applicable, gaseous impurities.

A three-stage filtration system offers the ultimate in protection thanks to a combination of coarse pre-filtration, fine dust filtration and final high-performance filtration for all-round protection of sensitive equipment.

However, the standard in most data centre applications is a two-stage filter system, as this effectively integrates air quality, energy consumption and maintenance aspects into a single system. In cases where contaminant loads are low, a single-stage filtration system may be a perfectly acceptable solution without putting operational reliability at risk.

The design criteria include low differential pressure over the entire service life, high dust holding capacity, as well as leak-proof installation systems tailored to the specific outdoor air load and facility layout.

Data centre aspects
Strategic, economic and environmental

Strategic
Filtration is used as a preventative measure to ensure availability and minimise risk. Stable air quality maintains the cooling coil performance, prolongs component service life, supports scalability by avoiding premature retrofits, and ensures conformity to HVAC as well as data centre standards. Integration into AHU, CRAH and CRAC systems as well as automation helps deliver consistent performance even with variable loads.

Economic
The total operating costs are primarily defined by energy and maintenance. Filters with low and stable pressure drops reduce the power consumption of fans, prolong service life and therefore reduce operating costs. A leak-proof installation minimises bypass air and therefore prevents efficiency losses as well as unplanned maintenance. Cost projections are improved and downtimes reduced by condition-based filter changes based on differential pressure drop trends.

Environmental
A lower energy requirement for the fans reduces indirect emissions. Durable, moisture-resistant materials and optimised filter change intervals reduce material consumption and waste. Systems should be disposed of at the end of their service life in compliance with local regulations and recyclable components should be removed and separated for recycling if possible. Selecting recyclable frames and environmentally friendly materials supports the ESG goals without impacting performance.

Normative references
and design objectives

ISO 16890 classifies particle filters based on their separation efficiency in relation to particle size ranges (ISO coarse, ePM10, ePM2,5, ePM1). A multi-stage combination of coarse and fine dust filtration is recommended for data centres. Pre-filtration stages protect downstream filters and surfaces, while final stages guarantee that sub-micron particles are reliably captured. ISO 10121 defines test methods for gaseous filter media and equipment; key indicators include separation efficiency, capacity and breakthrough time for sulphur dioxide, nitrogen dioxide, ozone and toluene (VOCs). Gas phase filtration is used if corrosion protection is required – often with reference to corrosion levels based on ISA 71.04 and the recommendations of ASHRAE TC 9.9.

Recommended
system architecture

A three-stage particle filter system with optional gas phase filtration has proven to be effective and provides maximum protection:

Information

Two-stage systems provide a proportional solution for many data centres. Single-stage filtration is sufficient for low loading, but first requires a detailed site analysis.

Stage 1

Dimensionally stable pre-filters with low initial pressure drop, selected based on outdoor air load (ISO coarse or ePM10); these remove coarse particles and reduce load to downstream filter stages.

Stage 2

Pocket filters with large filter area and moisture-resistant material, recommended in classes ePM2.5 or ePM1 for efficient fine dust separation.

Stage 3

Compact mini-pleat or V-bank filters for ePM1 high air volume final filtration. Durable seals are crucial for preventing bypass air.

Optional gas phase stage

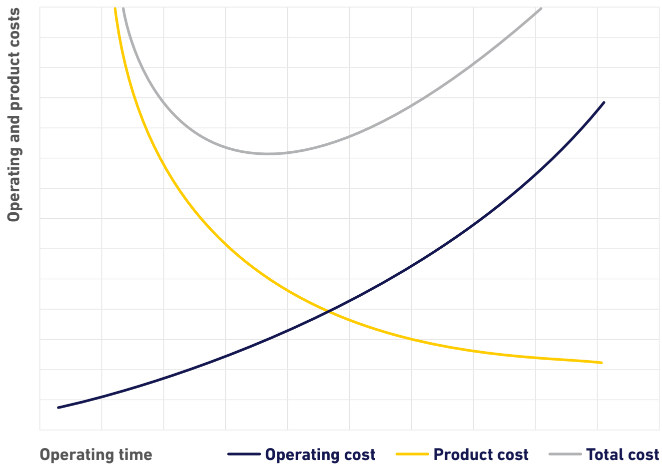
Activated carbon or impregnated media modules in accordance with ISO 10121 are used for gaseous contamination, designed to provide sufficient empty bed contact time based on site-specific gas profiles.

Selection criteria
and site adaptation

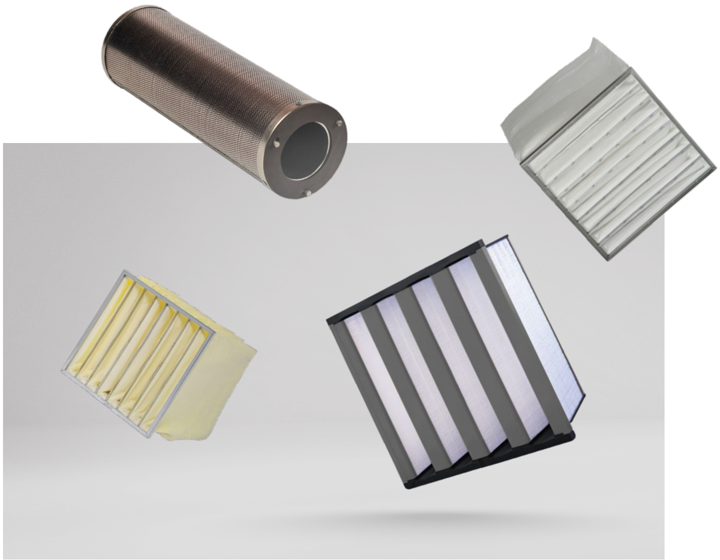
The system design begins with a detailed site analysis. High dust loading requires the use of multi-stage pre-filtration and filters with a high dust capacity. Humid, misty or saline environments require moisture-resistant materials, corrosion-resistant housing as well as droplet separators or weather louvres. A gas phase filtration system in accordance with ISO 10121 is integrated if any corrosive gases are detected. Bypass air flows are minimised by mechanical housing and sealing by means of reliable frames, seals and rails.

Energy efficiency
and total costs

Low and stable pressure drop reduces the fans' energy and extends filter change intervals. Life cycle costs include procurement, energy, maintenance and disposal. Filters with a low pressure drop increase caused by high dust loading offer a far more cost-efficient long-term solution. Leak-proof installations prevent bypass air, which reduces efficiency and increases energy consumption. In environments which generate high energy costs, an earlier filter change can be beneficial, often even before the recommended final pressure drop is reached.



Typical configurations
by load profile



Moderate outdoor air load
Standard combination of pre-filters and ePM10-/ePM2.5 pocket filters for efficient dust holding. Final ePM1 filtration is only performed if stringent cleanliness requirements demand it.

Energy-optimised systems
Pre-filters and ePM1 filters with large effective filter areas and low pressure drop can be used without affecting the separation of sub-micron particles.

Very dusty and humid environments
Combination of sturdy pre-filters with ePM10/ePM2.5 pocket filters for efficient dust holding prior to ePM1 final filtration. If necessary, this system can be enhanced by gas phase filtration.

Gas phase filtration
in practice

The design process starts with a definition of the target gases and concentrations. Test reports in accordance with ISO 10121 supply the parameters of separation efficiency, capacity and breakthrough times for gas filter elements and equipment under defined conditions. Even air distribution, sufficient adsorption bed depth and sealed housing are vital, while the empty bed contact time is also a key parameter. Operational monitoring of the pressure drop as well as gas measurement or corrosion testing ensure that parts are replaced in good time.

Operation, maintenance
and integration

Site-specific final pressure drop limits for each filter stage should be determined to trigger a replacement. Maximum inflow velocities should not be exceeded in order to prevent efficiency loss and an excessive pressure drop. Regular checks that filters are a proper fit as well as inspections of housing and seal integrity including potential leaks are absolutely essential. Water ingress at the outdoor air intakes should be minimised. Space, dimensions, and access for efficient servicing should be taken into consideration if integration into AHU, CRAH, CRAC or RTU is required.

Summary

A multi-stage system in accordance with ISO 16890 is recommended for reliable and efficient air cleaning in data centres. This can be enhanced if necessary by adding a gas phase filtration system in accordance with ISO 10121. The configuration should be tailored to meet the outdoor air and facility specifications. While three stages offer maximum protection, two-stage systems are actually the proven standard when it comes to cost and performance. Single-stage solutions may be used if low load levels are found after testing. A low pressure drop, high dust holding capacity and leak-free assembly are all crucial in achieving good results. These factors help minimise risks, stabilise the cooling capacity and sustainably reduce operating costs.

Reliable air filtration protects sensitive IT infrastructure, while delivering stable cooling capacity and utilising the maximum operating time in high-tech data centres.

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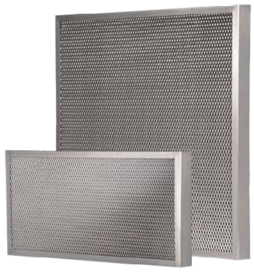
GAL metal mesh pre-filter



Features and advantages

Cleanable metal mesh; low initial pressure drop; reusable; dimensionally stable even after cleaning; reduced premature loading of downstream stages.

Benefits

Lower costs for consumables and less waste; stabilised coil cleanliness; reduced fan energy

ISO Coarse 40 %

Z-line panel pre-filter

Features and advantages

Pleated panels; frame: plastic, galvanised steel, cardboard. Flexibly adjustable; high stability; larger filter area compared with flat filters.

Benefits

Reliable separation during the first stage; predictable pressure characteristics; practical cost control; prolonged service life of downstream stages.

ISO Coarse 60 % to ePM10 50 %

K series pocket pre-filter

Features and advantages

Durable polyester fabric; moisture-resistant pockets; large effective filter area. High dust holding capacity; stable pressure drop over the entire life; ideal for humid/industrial sites.

Benefits

Longer replacement intervals; lower energy consumption; reliable protection for fine dust and final stages.

ISO Coarse 60 %–70 %; ePM10 50 %

G series pocket main filter

Features and advantages

Fibre glass fabrics; wide ePM1 efficiency range. Consistent separation of sub-micron particles; sturdy design for AHU systems.

Benefits

Reliable fine dust control; stable thermal capacity; scheduled maintenance intervals.

ePM1 50 %–80 %

N series pocket main filter

Features and advantages

Synthetic NanoWave material developed for low pressure drop. Lower fan energy requirement due to the achieved IAQ; longer service life thanks to stable loading properties.

Benefits

Reduced operating costs and CO_2; helps improve PUE; longer replacement intervals.

ePM1 65 %–85 %

MFHP compact filter

Features and advantages

Energy-optimised media set; variant with low pressure drop. Reduced fan power with the given air flow; good efficiency-energy balance.

Benefits

Lower energy consumption over the service life and TCO; supports ESG goals through reduced indirect emissions; stable IAQ for high load densities.

ePM1 60 %–80 %

Akolit activated carbon cartridges

Features and advantages

Application-specific carbon/carbon-impregnated materials; modular cartridges. Reliable separation efficiency and breakthrough times; can be adapted for site-specific gases.

Benefits

Reduced corrosion risk for PCB boards/terminals; improved facility reliability and service life; fewer gas-related interventions.

ISO 10121 related data

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Product information

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Glossary

Term	Description
AHU	Air Handling Unit – central air treatment system for outdoor or mixed air, with multi-stage particle and optional gas phase filtration, heating/cooling coils, humidification/dehumidification function and fans.
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers – international society for the development of standards and guidelines for the HVAC industry, particularly in relation to energy efficiency and room air quality.
CRAC	Computer Room Air Conditioner – circulating air cooling unit with direct expansion condenser (DX), mainly for cooling with filtered ambient air.
CRAH	Computer Room Air Handler – circulating air cooling unit with cold water coils, specially designed to cool and filter circulating air.
DX	Direct Expansion – a cooling system in which the refrigerant condenses into the coils to generate cool air.
ePM1, ePM2,5, ePM10	ISO 16890 particulate filter efficiency classes based on particle size ranges; ePM1 covers particles measuring ≤ 1 µm, ePM2.5 ≤ 2,5 µm, ePM10 ≤ 10 µm.
ESG	Environmental, Social, and Governance – set of criteria for evaluating the sustainability of companies, environmental standards, social responsibility, and ethical leadership.
IAQ	Indoor Air Quality – room air quality in relation to the concentration of contaminants, gases and particles which have a significant impact on health, productivity and the well-being of users.
IEEE	Institute of Electrical and Electronics Engineers – international professional organisation which defines technical standards for electronics and information technology relevant to, for example, infrastructure and control systems in data centres.
ISO	International Organization for Standardization – an international standardisation organisation responsible for the standards cited here (e.g. ISO 16890, ISO 10121).
ISO coarse	ISO Coarse – a particle-based filter class in accordance with ISO 16890, which specifies the separation efficiency of coarse particles (> 10 µm).
ISA 71.04	International Society of Automation, Standard 71.04 defines corrosive airborne environments relevant to electronics.
ISO 10121	Series of standards which define test methods and performance requirements for gas phase filtration materials and equipment.
PUE	Power Usage Effectiveness – ratio of the total energy consumption of a facility to the energy consumption of the IT equipment; used to measure the energy efficiency of data centres.
RTU	Roof Top Unit – compact HVAC system installed on the roof for decentralised treatment, cooling and filtering of return air for large buildings or halls.
TCO	Total Cost of Ownership, TCO – overall assessment of direct and indirect costs relating to a product or system over its entire life cycle.
VOC	Volatile Organic Compounds, VOC – organic chemicals which easily evaporate and may cause corrosion or contamination.

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People, processes and products – in every aspect of our work, we strive for sustainability and operational excellence in air filtration.

From carefully developed filter materials to complete multi-stage systems for data centres, each solution is designed to reduce energy requirements, prolong service life, and protect critical infrastructure. A combination of performance, reliability and environmental responsibility enables us to reduce emissions, optimise the use of resources and deliver long-term cost efficiency.

Reliable purifying capacity. Protecting technology.Supporting a sustainable future.

From each individual filter element right through to our overall strategy, everything we do works towards a single goal: cleaner air, safer environments and more sustainable processes for a digital world.

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