▶ Fresh air for offices ▶▶

Innovative room air strategies create ideal working conditions

TROX® TECHNIK
The art of handling air

▸ The art of handling air ▸▸

TROX understands the art of handling air like no other company. Since its foundation in 1951, TROX has been developing and manufacturing sophisticated components, units and systems for ventilation and air conditioning as well as for fire and smoke protection. Dedicated research and development have made TROX a global leader of innovation in these fields.

Demand-based office solutions of the future.
When we talk about the office of the future, IAQ, or indoor air quality, is only one concept that comes to mind. More often than not, we talk of IEQ, or indoor environmental quality. With regard to IEQ, it is the goal of each specialist consultant and architect to create a perfect environment with the best possible working conditions and the best possible room air conditions.

Over the past few decades TROX has gained much experience in office buildings and cooperates with the most creative and best engineers and architects to develop demand-based ventilation and air conditioning strategies that take the relevant criteria for each building into account and meet the requirements of its occupants. These development efforts have resulted in sustainable solutions that increase the well-being of people working in offices. In fact, scientists have been able to prove that, in addition to psychological factors, good room air has a positive and not to be neglected effect on performance levels.

▸ Perfect climate, perfect workflow ▸▸

Comprehensive system solutions.
From fans and air handling units to efficient filters, and from effective fire protection and smoke extract systems to air terminal devices, air-water systems and intelligent control components: The TROX portfolio comprises the entire spectrum of ventilation and air conditioning components, units and systems. We can hence provide our customers with complete solutions, not least for office buildings.

All TROX components, units and systems are engineered by TROX and ideally complement each other. Everything from a single source reduces the design and coordination effort considerably.

People come first.
Ventilation and air conditioning centre around people with their demands and needs. This is why we are committed to develop effective solutions in order to ensure maximum comfort and safety for people.
To create room air conditions that help people perform better, ventilation and air conditioning should basically meet the following requirements:

- Ensure a sufficient fresh air flow rate.
- Discharge the air to the occupied zone with as little turbulence and noise as possible.
- Filter fresh air to keep fine dust, pollen and other contaminants away.
- Provide individual air quality control and high thermal comfort.
- And last, but not least, link components intelligently, thereby ensuring their efficiency at all times.

What room air conditioning should achieve:

- Supply fresh air
- Remove contaminants, gases and vapours
- Dilute emissions such as CO_2 or formaldehyde
- Remove substances such as dust or fungal spores
- Provide heating
- Dissipate heat loads created by people, lighting, equipment
- Humidify and dehumidify air
- Filter air
- Ensure energy efficiency, e.g. by means of heat recovery

The following application brochures are also available:

- *Hotels*
- *Clean rooms*
- *Hospitals*
- *Labs*
- *Airports*

Edificio IDOM, Bilbao, Spain

Hypercube, Moscow, Russia

Riverside Park, Warsaw, Poland

► Room air quality as a productivity factor ►►

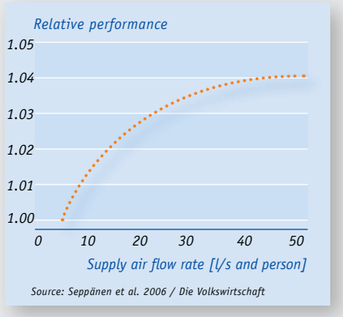
Researchers in Berkeley, California, studied the interrelation of indoor environmental quality and occupant performance and calculated the resulting economic benefit.

The researchers have actually been able to show that increasing the supply air flow rate in offices may lead to an increase in performance levels by up to 4 % (Fig. 1). By far more interesting, however, are the findings regarding the satisfaction of room occupants since their expectations and general constitution greatly affect how they perceive the quality of the room air. The higher the supply air flow rate, the more people are satisfied, and then significantly (Fig. 2) – this is an immensely important aspect since motivation and well-being, but also the sick leave rates (reduction by up to 35 %), correlate to a large extent with employees' satisfaction.

And yet the modernisation of ventilation and air conditioning systems is often delayed since it incurs high investment costs. Increasing the fresh air rate is often delayed, too, due to the higher energy consumption.

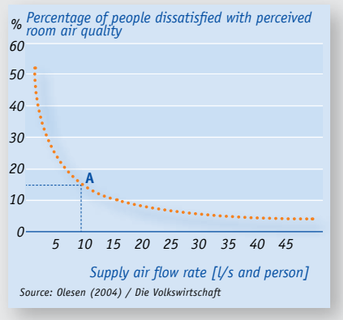
The impact of good office air on a nation's economy cannot be denied: US researcher William J. Fisk carried out a cost-benefit analysis and has been able to prove that the economic benefit by far exceeds the investment into good room air quality. Studies suggest that if all office buildings in the US were refurbished (flow rate adapted to 10 l/s per person, room temperature of 23 °C max. in winter, further technical measures), the annual benefit to the US due to better performance in the workplace and fewer absences due to sickness would amount to USD 20 billion.

Fig. 1: Relation between ventilation and performance in offices



Source: Seppänen et al. 2006 / Die Volkswirtschaft

Fig. 2: Percentage of dissatisfied employees with different supply air flow rates



Source: Olesen (2004) / Die Volkswirtschaft

How to read the chart: With a supply air flow rate of 10 l/s, 15 % of people perceive the air quality as not satisfactory.

On the right: Statoil building near Oslo, Norway

Goods Shed, Melbourne, Australia

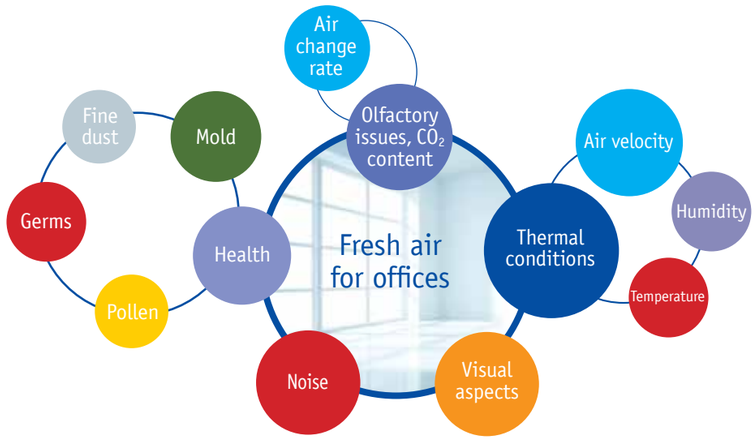
Am Fleischmarkt, Vienna, Austria

SPIEGEL publishing house, Hamburg, Germany
© Noshe/DER SPIEGEL

► Factors in selecting an air conditioning system ►►

The air conditioning strategy for an office building depends on many factors. It begins with structural conditions such as architecture, building envelope, location and orientation, and the layout and size of rooms. Next, occupancy, loads to be dissipated, and the usage and equipment of offices all play an important role. And finally, the air conditioning system depends on whether it is designed for a new building or for a refurbishment. Existing buildings, i.e. refurbishment projects, do obviously not provide the same degree of planning freedom as new builds.

The wide spectrum of air conditioning systems, units and components puts TROX into a unique position: being able to provide a bespoke solution for different conditions and for each office building. The sheer number of proven solutions, and the extensive expertise that TROX engineers have built up over the years and by working on the most diverse projects all over the world, provide our customers with tailored air conditioning systems and hence a very good room air quality. The prestigious reference projects we introduce in this brochure are proof of that.



Typical decision criteria for air conditioning systems:

Type of usage
- Operating hours
- Occupancy
- Flexible room use due to retrofit components

Room air
- Temperature
- Relative humidity
- Heating/cooling loads
- Fresh air requirement
- CO_2/VOC concentration

Types of rooms
- Size
- Cellular office/open plan office
- Conference room
- Reception area or similar

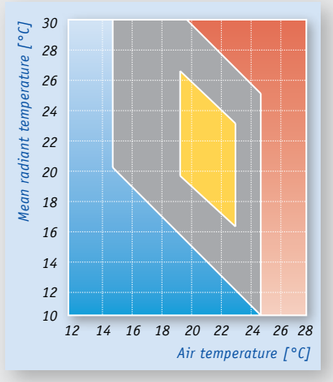
New building
- Architecture/building envelope
- Type of structure
- Room dimensions

Refurbishment
- Type of structure
- Space available for air conditioning
- Existing ductwork

Location
- Building orientation
- Regional climate/solar gain
- Fresh air contamination level

Other factors
- Economic efficiency
- Sustainability

Comfort criteria



► Architectural trends affect the air distribution ►►

Omission of suspended ceilings.
Many architects prefer open and transparent building structures and would like to integrate ventilation and air conditioning systems as unobtrusively as possible. Components are either hidden in ceilings, walls or façades; or they may be openly presented. Either way, suspended ceilings are no longer an issue for architects.

Other reasons for omitting suspended ceilings are the saving of costs and a trend towards thermal component activation. Pipes for heating or cooling media, usually water, are laid in ceilings and walls, affecting phase changes and helping to smooth or shift peak loads. Component activation is best combined with regenerative heating and cooling systems, e.g. a heat pump. Ventilation and air conditioning should be flexible enough to allow for changing uses, particularly of office buildings. Ideally, control strategies take the weather forecast into consideration.

Another trend that restricts air distribution through a suspended ceiling is the increasing number of refurbishment projects. Rooms of refurbishments are usually not high enough to accommodate a suspended ceiling. It is up to manufacturers such as TROX to develop flexible air distribution systems that can be adapted to different conditions. Combination diffusers installed in walls between rooms and corridors are an excellent choice.

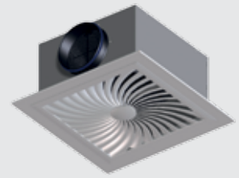
Demand-based control is characterised by large fluctuations of the supply air. For the best results, however, diffusers require a certain minimum volume flow rate. If the volume flow rate is lower than the required minimum, it may happen with temperatures below the room temperature that, due to the low velocity, the airflow suddenly detaches itself from the ceiling, and the supply air falls vertically into the occupied zone, causing draughts there. One way to avoid this is by increasing the number of blades of swirl diffusers such that they may also be used with lower volume flow rates.

ECB, Frankfurt, Germany

Special product features

Technical function independent of the design
Optimised, low-leakage plenum boxes achieve a homogeneous air distribution, minimum pressure losses and only very low air-regenerated noise levels.

Freely suspended swirl diffusers with extended border *make use of the Coanda effect when installed in open ceilings.*



Higher number of blades
More blades create more individual air jets which make swirl diffusers also suitable for smaller volume flow rates.

Perforated blades
A small proportion of the supply air flows through the perforation, whereas the major part flows over the blade. The partial airflows converge on the downstream side. This allows for higher supply air flow rates while contamination is reduced.

System selection

All-air systems vs air-water systems

All-air systems

The most important criterion when deciding between an all-air system and an air-water system is obviously the cost, apart from the fresh air requirement [in $m^3/h.m^2$] and the cooling load [in W/m^2]. If one takes into account how much space is saved, the differences in the life cycle costs for all-air systems and air-water systems are small.

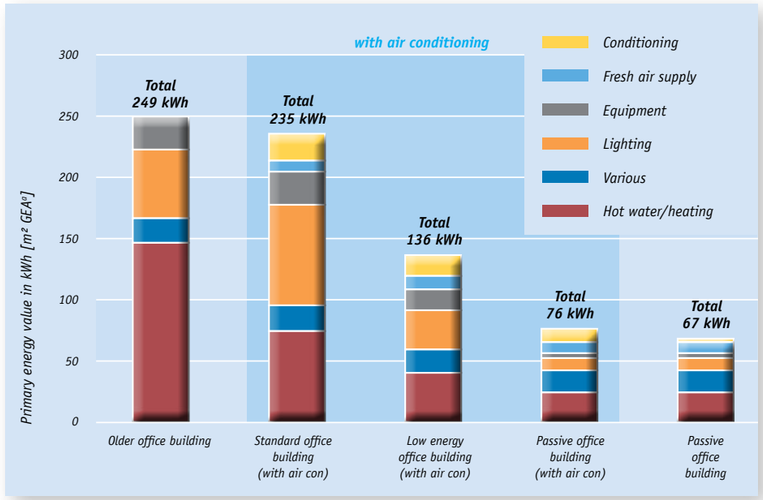
In rooms with many people, good air quality can only be achieved with a sufficient fresh air volume flow rate that is based on the number of these people. This is usually an argument in favour of a classical all-air system.

Modern office and administration buildings contain much technical equipment and often have large areas of glazing. The heat emitted by the equipment plus the solar gain due to large windows may heat a room considerably without the air quality being impaired by contamination.

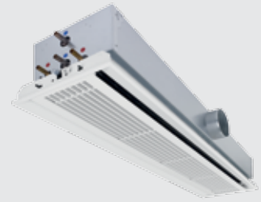
An all-air system would require large volume flow rates for cooling such rooms and incur high energy costs for air treatment and air transport. In this case air-water systems and decentralised ventilation systems with an integral air-to-water heat exchanger are the preferred choice since the heating and cooling capacity of these systems is independent of the fresh air flow rate. An additional advantage of air-water systems is the fact that thermal energy is transported more efficiently by water than by air such that less energy, and less space, is required to provide the same heating or cooling capacity.

Renewable energy for ventilation and air conditioning.

State-of-the-art ventilation and air conditioning strategies play a significant role in achieving the goal of reduced carbon emissions. Just the existing technologies for exploiting renewable energy sources, such as solar energy, geothermal energy, free cooling, heat recovery and waste air, may suffice to contribute until 2020 approximately 9 % to the climate protection goal of the Federal Republic of Germany.



Primary energy values for buildings with different energy performance:
The savings potential for office buildings is considerable when state-of-the-art ventilation and air conditioning systems are used and when outdated components and systems are replaced.



Air-water systems

Decentralised ventilation

Air distribution

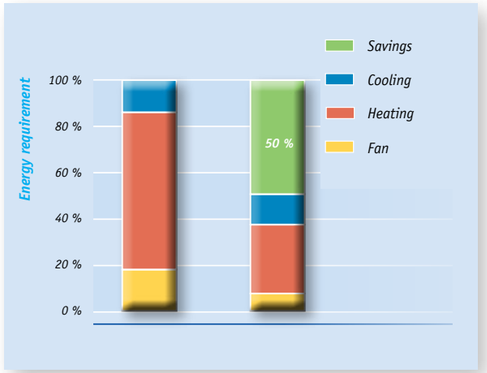
Control: constant and variable volume flows

Constant air volume systems.
Constant volume flow systems provide a constant volume flow rate. This is why they can only be used when the air conditioning system is not used for heating, i.e. when temperature control for individual zones is achieved with other systems (e.g. radiators), when no temperature control is required at all, or when the air quality does not vary much. Constant volume flow systems are a typical choice for rooms where the usage does not vary within a day. Call centres are a good example: They are always staffed with the same number of peope, who work in shifts, 24 hours a day, 365 days a year.

Demand-based ventilation with variable volume flow systems.
Demand-based control strategies are adapted to the room usage and therefore result in considerable energy savings. The amount of energy required for providing and conditioning air (heating, cooling, humidifying, dehumidifying) is always adapted to the actual demand.

People will feel equally comfortable as long as the temperature and humidity levels lie within a certain range. This fact is made use of by intelligent control strategies, which select the best possible combination of values based on energy efficiency. Demand-based control is characterised by large fluctuations of the supply air. For the best results, however, certain diffusers require a minimum volume flow rate.

Energy savings due to demand-based ventilation



Combination of constant and variable volume systems.
It may be possible to have areas with constant volume control and areas with variable volume control, or to use air distribution systems with different sections for constant volume flow and variable volume flow. For example, meeting rooms on different floors but at the same place in the floor layout may be connected to a separate all-air air handling unit, which allows for individual variable volume flow control based on the usage and occupancy, while the standard offices have all-air systems with constant air volume control or air-water systems.

Bank of America Tower at One Bryant Park, New York, USA

Control factors for high air quality and energy efficiency

- Individual control for each zone
- Shut-off and other forced actions
- Variable volume flow rate between V_{min} and V_{max} or switching between operating modes
- No adverse effect between control circuits
- Setpoint change is possible at any time
- Decentralised control
- Integration into the central BMS

Air discharge

Selecting air terminal devices

When selecting a supply air diffuser, the exact installation location is as important as the cooling load of a room. If one compares a room air conditioning system to a chain, air terminal devices would be the most critical links for thermal comfort. They are supposed to ensure that the occupied zone meets the most demanding requirements of thermal comfort: Room air conditioning is perceived as ideal if you cannot hear it or feel it.

Mixed flow or displacement flow ventilation?
With mixed flow ventilation, a uniform temperature and air distribution are quickly achieved. The supply air is discharged with a velocity of 2 to 5 m/s, mixes with the room air and dilutes in this way the contaminant concentration. Turbulent mixed flow ventilation can achieve higher air change rates and better room purging. It is the preferred solution for areas with a high occupancy level and for areas where the air conditioning system is also used for heating.

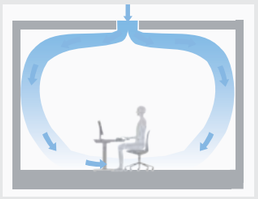
Displacement flow ventilation is characterised by low airflow velocities, low turbulence and a high air quality in the occupied zone. The supply air is discharged into the space with a low velocity and as close as possible to the floor; the result is a pool of fresh air over the entire floor area. The convection from people and other heat sources causes the fresh air from the pool to rise and create comfortable conditions in the occupied zone.

Inducing displacement flow.
An inducing displacement flow combines the advantages of both types of ventilation. The supply air rises in the near zone of displacement flow diffusers with a velocity of 1 to 1.5 m/s and mixes with the room air. Once the momentum of the jet dies out, the jet becomes a displacement flow. Due to the low levels of turbulence both inducing displacement flow ventilation and displacement flow ventilation meet the requirements of room air category A.

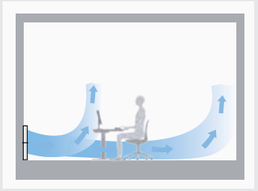
Central vs decentralised air conditioning systems.
Central air conditioning requires ductwork and hence space. This space is usually not availabe with refurbishments. In such cases the perfect alternative for both refurbishments and new builds are decentralised façade units. The fresh air connection is provided by ventilation openings in the façade system or external wall. Decentralised ventilation and air conditioning units are suitable for rooms with a depth of up to seven metres, depending on the room layout and furniture.

Mondrian, Brussels, Belgium

Types of ventilation



Mixed flow



Displacement flow

Integrated planning

Multiple solutions for healthy room air

Given the sheer number and diversity of ventilation and air conditioning components, units and systems for office buildings, standards such as VDI 3804 provide valuable guidance for specialist consultants in Germany and beyond. These standards deal with four different air distribution systems that may be used separately or combined:

- A: All-air systems with variable volume flow
- B: All-air systems with constant volume flow
- C: Central air-water systems (induction units)
- D: Decentralised air-water units (façade ventilation systems)

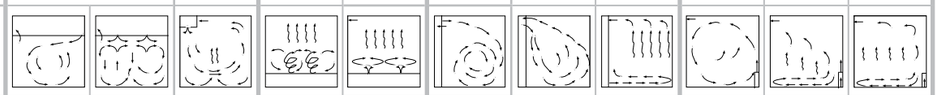
A	B	C	D
Central			Decentralised
All-air system with cooling		Air-water systems	Air-water systems
VAV	CAV	CAV	VAV
Air cooling	Chilled ceiling	Induction units	Decentralised cooling Sill or under sill, underfloor, ceiling
Static heating		Decentralised – heat exchanger	Decentralised heating / Decentralised heating + CA*
Specific fresh air flow rates with m² UFA 6 … 25 m³/h/m²	5 … 8 m³/h/m²	5 … 8 m³/h/m²	5 … 8 m³/h/m² / 5 … 8 m³/h/m²
Specific fresh air flow rates with m² UFA up to 80 W/m²	up to 100 W/m²	up to 80 W/m²	up to 70 W/m² / up to 70 W/m²
Air discharge			
Floor / Wall / Ceiling		Floor / Wall / Ceiling	Underfloor / Sill/ under sill / Wall/ceiling
Mixed flow – swirl and slot diffusers		active	Underfloor air-water systems / Sill and under sill air-water systems / Façade air-water systems
Inducing displacement flow – swirl diffusers		passive	
Displacement flow diffusers			
All-air + all-air plus passive chilled beams			Alternative: decentralised all-air systems

The tables on the fold-out page provide information on the principal standards and guidelines as well as on the sizing of air conditioning systems for office buildings.

*component activation

Design criteria	Work areas				Other rooms			
	Cellular offices	Open plan offices	Conference rooms	Auditoriums	Corridors	Break room	Washrooms	Copy room
Fresh air flow rate in m³/(h m²)	5.1	4.4	15.2	40.4	2.6	20.2	1.6	2.6
Fresh air flow rate in l/(s m²)	1.4	1.2	4.2	11.2	0.7	5.6	0.42	0.7
Area per person (estimate) in m²/pers.	10	15	2	0.75	-	1.5	-	-
Design values for room temperature [°C]								
Typical min. room temperature when heating (winter)	20	20	20	20	16	20	20	16
Typical max. room temperature when cooling (summer)	26	26	26	26		26		
Sound pressure level [dB(A)]								
Typical range	30 - 40	35 - 45	30 - 40	30 - 35	35 - 45	35 - 50	40 - 50	
Standard value	35	40	35	33	40	40	45	
Volume flow controllers, supply and extract air								
VAV terminal units	•	•	•	•	o	•	o	o
CAV controllers		o			•		•	•

Ventilation systems by point of discharge and type of ventilation according to VDI 3804

Type of ventilation											
Installation location	Ceiling			Floor		Wall			Façade		
Type of ventilation	MF		IDF	IDF	DF	MF	IDF	DF	MF	IDF	DF
Air pattern											
Max. cooling load W/m²	≤ 60	≤ 100	≤ 80	≤ 100	≤ 40	≤ 60	≤ 60	≤ 40	≤ 60	≤ 80	≤ 40
Supply air to room air temperature difference at 1.1 m above the floor	-3 to -5	-8 to -12	-6 to -8	-6 to -8	-1 to -3	-4 to -6	-6 to -8	-1 to -4	-4 to -6	-6 to -8	-1 to -3
Supply air to extract air temperature difference	-3 to -5	-8 to -12	-7 to -10	-8 to -12	-2 to -7	-4 to -6	-7 to -10	-2 to -8	-4 to -6	-7 to -10	-2 to -7
Ventilation effectiveness	1	1	1.2	1.5	2	1	1.2	2	1	1.2 to 1.5	2
Air terminal devices											
Slot diffusers	•	•	•			•	•				
Displacement flow diffusers				•	•			•			•
Swirl diffusers		•		•							
Ventilation grilles	•	•		•		•	•	•	•	•	•
Floor diffusers				•	•						
Air-water induction units	•	•		•		•	•	•	•	•	•
Jet nozzles		•				•					

● recommended o – recommended under certain conditions MF - mixed flow IDF - inducing displacement flow DF - displacement flow

Principal standards and guidelines:

Ventilation and air conditioning systems

EN 16798-3	Draft: Energy efficiency of buildings; part 3: Requirements for ventilation systems, air conditioning systems and refrigeration systems
EN 15251 rev	Ventilation: Indoor environmental input parameters
EN 779	Particulate air filters for general ventilation (filtration efficiency)
EN ISO 7730	Ergonomics of the thermal environment
VDI 3804	Air-conditioning – Office buildings
VDI 6022	Hygiene requirements for ventilation and air conditioning systems and units
EN 1751	Ventilation for buildings – Air terminal devices – Aerodynamic testing of damper and valves

Fire protection and smoke extract systems

CPR	EU Construction Products Regulation
EN 13501-4	Fire classification of construction products and building elements; components of smoke control systems
EN 13501-3	Fire classification of construction products and building elements; fire resisting ducts and fire dampers
EN 12101-8	Smoke and heat control systems – Smoke control dampers
EN 12101-3	Smoke and heat control systems: Powered smoke and heat exhaust ventilators
EN 1366-2	Fire resistance tests for service installations – Fire dampers
EN 1366-10	Fire resistance tests for service installations – Smoke control dampers
VDI 6010	Technical safety installations – Automation and control of fire protective services
EN 15650	Ventilation for buildings – Fire dampers (product standard)
EN 15882-2	Extended application of results from fire resistance tests for service installations – Part 2: Fire dampers
EN 1363-1	Fire resistance tests – Part 1: General Requirements
ISO 10294-4	Fire resistance tests – Fire dampers for air distribution systems – Part 4: Test of thermal release mechanism

Complete room air systems

Complete room air conditioning systems from a single source

TROX has set itself the goal of minimising interface issues with regard to components and trades. This is why we offer all ventilation and air conditioning components, units and systems from a single source: from air handling units to air terminal devices and to automation and communication systems. The decisive advantage for specialist consultants and HVAC contractors is the fact that they have only one point of contact; this reduces the communication and coordination effort considerably.

One-stop shop

One point of contact – less coordination effort.

On the following pages we show you, as an example, two office buildings, a new build and a refurbishment with different room air conditioning equipment. Follow the way of the airflow through the office buildings from the air handling unit to the air terminal devices.

TROX covers the entire range of components, units and systems for ventilation and air conditioning.

- *Air entry – weather protection*
- *Air treatment/heat recovery*
- *Air transport*
- *Air removal – smoke extract*
- *Air shut-off – fire protection*
- *Air distribution*
- *Air discharge*

1 **X-CUBE air handling units** are configurable and handle volume flow rates of up to 86,000 m³/h (24,000 l/s) for the ventilation and air conditioning of rooms – including filtration, heating, cooling, heat recovery, and humidifying and dehumidifying.

2 **X-CUBE compact** is a compact air handling unit for volume flow rates of 600 to 6000 m³/h and a heat recovery efficiency in excess of 80 % (dry, to EN 308); it is the ideal solution for small and medium-sized applications.

3 **VAV terminal units combined with the X-AIRCONTROL zone control system** provide demand-based volume flow rate control to ensure the best possible room air quality and temperature while they help to save energy at the same time.

4 **Medium filters M5** are used in ventilation and air conditioning systems to separate contaminants from the air.

5 **Fine dust filters F7** are used for the separation of fine dust in ventilation systems that have to meet demanding requirements. TROX filters of filter classes M5 to F9 are tested to EN 779 and certified by EUROVENT.

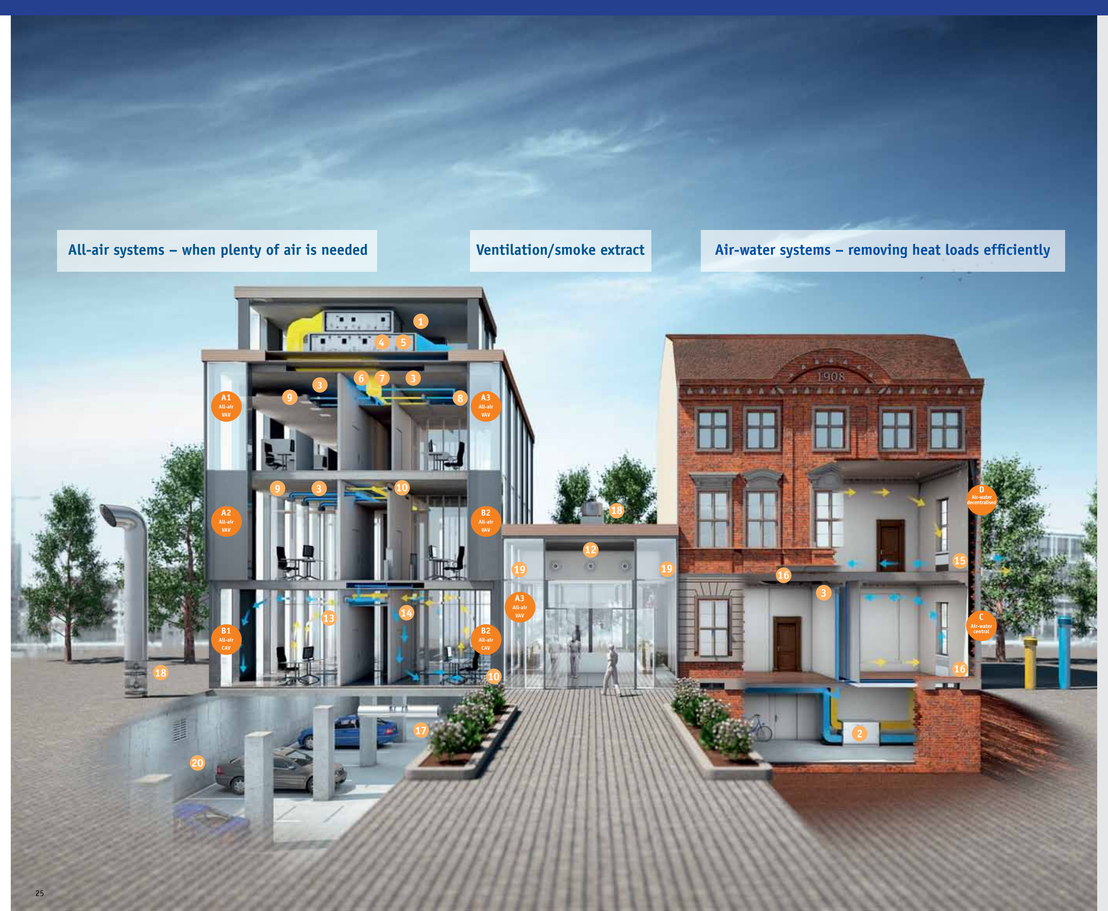
6 **TROXNETCOM** makes use of decentralised, open communication systems and hence allows for inexpensive fire protection solutions that can be easily integrated with the central BMS.

7 **Fire dampers** from TROX are certified for all European countries and prevent fire and smoke from spreading through ventilation ducting. The fire area is consequently shut off from other parts of the building.

8 **Slot diffusers** provide efficient air discharge and can be subtly integrated into suspended ceilings.

9 **Swirl diffusers** with optimised acoustic and aerodynamic properties come in a wide range of designs and constructions to suit every architectural requirement. They may be installed in suspended ceilings or just below the ceiling and hence visible.

10 **Single ventilation grilles and continuous horizontal runs** with adjustable front blades may be installed in walls and in circular and rectangular ducts.



TROX components, units and systems in an office building:

1 Air handling units
2 Compact air handling units
3 Control units/zone controllers
4 Medium filters
5 Fine dust filters
6 TROXNETCOM
7 Fire dampers
8 Slot diffusers
9 Swirl diffusers
10 Single ventilation grilles and continuous horizontal runs
11 Displacement flow diffusers
12 Jet nozzles
13 Combination mixed flow diffusers
14 Combination displacement flow diffusers
15 Decentralised ventilation units
16 X-BEAM induction units
17 X-FANS jet ventilation systems
18 X-FANS smoke exhaust fans
19 Smoke control dampers
20 Tunnel and industrial dampers

A All-air systems (variable airflow)
B All-air systems (constant airflow)
C Air-water systems
D Decentralised air-water units

Displacement flow diffusers provide a low-turbulence supply air flow at a very low discharge velocity. 11

Jet nozzles throw the air far into the room. The nozzles are actuated electrically, manually, or with an SMA actuator (self-powered) and can be operated in heating or cooling mode. 12

Combination diffusers for mixed flow ventilation are space saving diffusers used for both supplying air and extracting air; they can be installed in walls. 13

Combination diffusers for displacement flow ventilation are used for both supply and extract air and provide a comfortable displacement flow. 14

Decentralised ventilation units can be integrated with façade systems. State-of-the-art control technology and energy-efficient heat recovery systems ensure ideal room ventilation. 15

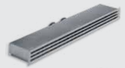
X-BEAM induction units are air-water systems and represent energy-efficient solutions for the ventilation and air conditioning of rooms. Ceiling mounted units can be fitted with additional functions or building services, e.g. lighting. 16

X-FANS jet ventilation systems are an excellent alternative to duct-based ventilation and smoke extract systems for underground car parks. 17

X-FANS smoke exhaust fans remove hot fire smoke in the event of a fire, allow people to move to safety, protect property and make it easier for firefighters to put out the flames. They can also be used for ventilation purposes. 18

Smoke control dampers with extract ventilation function, for smoke extract with mechanical smoke extract systems. 19

Tunnel and industrial dampers are used for the ventilation and smoke extract in underground transport systems and car parks. 20



All-air systems

© Amisola/Gregor Titze

High demand for air requires optimum air discharge

If rooms are occupied with many people, good air quality requires frequent air changes; this is usually achieved with a classical all-air system.

The type of air discharge.
Displacement flow ventilation allows for the dissipation of only small cooling loads of 30–50 W/m². It is often used in combination with chilled ceilings, which withdraw heat from the room. Ventilation in cooling mode is very effective, i.e. a very good air quality is achieved in the occupied zone – higher than with a turbulent flow (mixed flow ventilation); this is one of the main advantages of displacement flow ventilation. It is, however, not suitable for heating purposes, and neither for each type of office structure or each type of furniture.

Turbulent mixed flow ventilation allows for higher air change rates and better room purging. It is preferably used for rooms with a high occupancy.

Aerodynamic optimisation.
Aerodynamically optimised air terminal devices are extremely important. Perfect aerodynamic properties ensure maximum safety and thermal comfort in particular with swirl diffusers since the originally high velocity of the turbulent airflow and temperature differences are rapidly reduced.

The installation location also affects the room temperature patterns between the floor and the ceiling and hence on how temperatures are perceived by occupants.

On the next six pages we present various all-air systems and give recommendations for product selection.

Am Fleischmarkt, Vienna, Austria

Selected air terminal devices for various types of discharge:

Mixed flow
Swirl diffusers
- Rapid change of large air volumes
- For small and large rooms

Ceiling diffusers
- For large air volumes
- Many designs, can be integrated into all types of ceilings

Ventilation grilles
- Classical air terminal devices
- For supply and extract air

Slot diffusers
- Effective air discharge
- Unobtrusive integration
- Adjustable blades for different air patterns

Jet nozzles
- Throw the air far into the room
- Electric/manual/self-powered adjustment
- For heating and cooling
- For very large rooms

Combination diffusers
- Inexpensive and space saving solution for supply and extract air
- Installation in partition walls, bulkheads or suspended ceilings

Mixed flow / displacement flow
Floor diffusers
- Combine the advantages of mixed flow ventilation and displacement flow ventilation
- Meet demanding acoustic requirements

Displacement flow
Displacement flow diffusers
- No turbulence, no draughts
- Good solution for cooling
- Space saving installation in walls or in corners

Staircase swirl diffusers
- Installation in false floors, preferaby in auditoriums etc.

Berlaymont, Brussels, Belgium

TROX VSD35 slot diffusers
- 13 – 140 l/s
  45 – 500 m³/h
- L: 600 – 1,950 mm
  1–4 slots

TZ-Silenzio VAV terminal unit with highly effective, integral sound attenuator
- 30 – 840 l/s
  108 – 3,024 m³/h
- ☐125 – 315 mm
  Δp: 5 – 1,000 Pa

Casing air leakage: EN 1751, class C

X-AIRCONTROL room and zone control controls the room climate based on room temperature, room air quality and occupancy.

For more solutions and products please visit ***www.trox-office-air.com***

▶ Variable mixed flow ventilation ▶▶

If very diverse architectural and usage parameters need to be considered in the ventilation and air conditioning design process for an office, variable volume flow control is the best solution. Variable volume flow control ensures that the airflows are automatically adjusted to usage changes. The automatic adjustment to changing parameters due to intelligent control and communication systems increases the efficiency of a system considerably.

TROX slot diffusers of Type VSD35 are available with 1 to 4 slots. No matter how many slots a diffuser has, the diffuser face is an extrusion, made from one piece, which means that no seams are visible. Their compact height makes slot diffusers ideal for ceiling voids and in particular for suspended ceilings, while their high induction results in a rapid reduction of the supply air to room air temperature difference and airflow velocity.

VAV terminal units of Type TZ-Silenzio are designed also for low airflow velocities. They are whisper quiet, thereby increasing the comfort and air quality in the workplace; moreover, they require very little space since no upstream section is necessary.

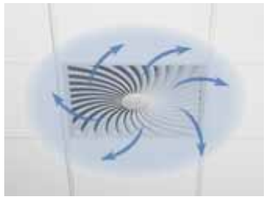
TROX, Neukirchen-Vluyn, Germany

▶ Swirl diffusers for a rapid air change ▶▶

If a rapid air change is required, TROX swirl diffusers are just what is needed. There is hardly any other manufacturer who offers such a wide range of construction variants and attractive designs. Whether installed freely suspended (and with an extended border) or flush with the ceiling, the diffusers always blend in perfectly with the room architecture and offer ideal solutions for both large and small offices. Depending on the construction, swirl diffusers can provide a comfortable airflow at 25 – 40 % of the maximum volume flow rate.

Success factors for effective air discharge.
An ideal air discharge pattern can be achieved with high induction levels that lead to a rapid reduction of airflow velocities and of the temperature differences between supply air and room air.

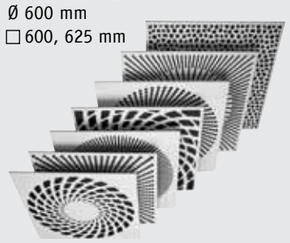
For many years TROX has studied the use of plastics and implemented its findings in the design of perfect swirl diffusers. Three-dimensional blade contours, which are so perfectly shaped that they can only be produced in plastic, create a comfortable airflow and ensure that the supply air mixes well with the room air.



AIRNAMIC and XARTO swirl diffusers are fitted with innovative blades that combine an extremely quiet air discharge with the optimum swirl; the above-mentioned comfort criteria can be met even with very high volume flow rates.

AIRNAMIC swirl diffusers
- 13 – 385 l/s
  47 – 1,386 m³/h
- ☐ 300, 400, 600, 625 mm
  Ø 400 and 600 mm

XARTO swirl diffusers
- 31 – 265 l/s
  110 – 954 m³/h
- Ø 600 mm
  ☐ 600, 625 mm



VDW air terminal devices
- 7 – 470 l/s
  25 – 1,692 m³/h
- Ø 300 – 625 mm
- ☐ 300 – 825 mm

ADAC, Munich, Germany

A3
All-air VAV

TJN jet nozzles
- 20 – 1000 l/s
  72 – 3,600 m³/h
- Ø 160 – 400 mm

PASSCLEAN ceiling diffuser
- 83 – 200 l/s
  300 – 800 m³/h
- Ø 600 mm, □ 600/625 mm

For more solutions and products please visit
www.trox-office-air.com

▸ Jet nozzles for high volumes ▸▸

Large and high reception areas require air terminal devices that can throw the air far into the room. Intelligent control systems ensure that the airflow is quickly adapted to uses of varying intensity and to varying climate conditions.

TJN adjustable jet nozzles: The use of advanced polymer technology opens up entirely new design options. TJN jet nozzles allow for the precise adjustment of the supply air jet to the prevailing room conditions. The nozzles are acoustically optimised, and the flat external motor ensures energy efficiency. Additional pressure losses are avoided.

An innovative option: Due to so-called shape memory alloys the discharge angle of jet nozzles changes based on the supply air temperature, thereby ensuring the comfort criteria in the occupied zone, both in heating and in cooling mode.

PASSCLEAN ceiling diffusers were originally developed for areas with a high degree of foot traffic. The clever air discharge prevents the diffuser and the ceiling from becoming dirty after a short time.

▸ Extract air removal with aesthetic grilles ▸▸

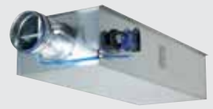
Ventilation grilles are the classic way to discharge supply air to rooms, but also to remove extract air. As an alternative, air terminal devices or perimeter gaps between a suspended ceiling and the wall can be used for extract air.

The new X-GRILLE ventilation grille is made of high-quality aluminium and combines function with an attractive design. It may be installed in walls or in rectangular ducts. Its nicely designed cover plates are easy to remove and replace with other cover plates. The two-colour variant allows for a lively impression. The grille has been awarded the Interior Innovation Award and the Iconic Award 2014.

X-GRILLE ventilation grille
- 16 – 2,651 l/s
  58 – 9,544 m³/h
- 225 x 125 – 1225 x 525 mm

VAV terminal unit TVZ for high acoustic comfort
- 15 – 1680 l/s
  54 – 6,048 m³/h
- Ø: 125 – 400 mm
  Δp: 5 – 1,000 Pa

Casing air leakage: EN 1751, class A



For more solutions and products please visit
www.trox-office-air.com

B1
All-air
CAV

SEF Engineers, Karlsruhe, Germany

Combination diffusers of Type VSD35-3-AZ
- 10 – 40 l/s
  40 – 140 m³/h
- L: 600 – 1,200 mm
  H: 110 mm
  3 slots

Combination diffusers of Type VSD50-1-LT
- 14 – 55 l/s
  50 – 200 m³/h
- L: 550 and 1175 mm
  B: 70 mm

With integral acoustic lining

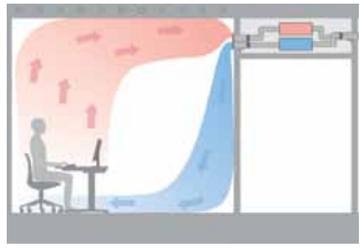
CAV controller of Type EN
for higher volume flow rates
- 40 – 3,360 l/s
  144 – 12,096 m³/h
- B: 200 – 600, H: 100 – 600 mm
  Δp: 50 – 1,000 Pa

Casing air leakage to EN 1751, class C

For more solutions and products please visit
www.trox-office-air.com

▶ Displacement flow ventilation – Diffuser above the corridor ▶▶

Type QLW-AZ displacement flow diffusers for supply and extract air ensure high thermal comfort since there is only a small difference between supply air and room air, and the airflow is of low turbulence. They are not suitable for the dissipation of high heat loads, which is why a combination with thermally activated components or with a passive chilled beam is common.



Displacement ventilation means that air is supplied to the room with very little momentum; it then rises due to the convection from people and other heat sources such as electrical equipment or lamps.

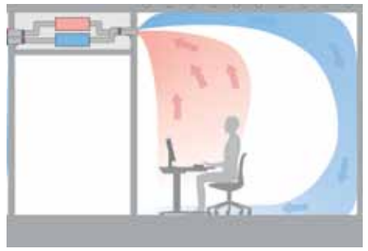
As an alternative, classical displacement flow diffusers may be combined with component activation or passive chilled beams installed close to the floor.

▶ Mixed flow ventilation – Air terminal device in the partition wall ▶▶

For solid structures without suspended ceilings, or when an existing office building is to be refurbished, combined supply/extract air terminal devices are the ideal solution and economic at that.

Combined air terminal devices from TROX are available as mixed flow diffusers or as displacement flow diffusers. Combination units are typically installed in suspended ceilings, bulkheads or lightweight partition walls in the corridors of office buildings. This saves space. Optional or integral acoustic lining effectively prevents the transmission of noise or room-to-room crosstalk.

Type VSD35-3-AZ combination units make use of the Coanda effect.
The supply air is discharged from the upper slot, moves along the ceiling and eventually fills the entire space. With an activated concrete ceiling, the airflow increases the component activation effect. The extract air is taken in through the two lower slots. With their compact, slim construction these diffusers ideally fit into restricted spaces.



QLW-AZ combination displacement flow diffusers
- 14 – 42 l/s
  50 – 150 m³/h
- L: 600 – 1,200 mm, H: 250 mm

QL-WV-RO-K displacement flow diffusers
- 14 – 309 l/s
  49 – 1,113 m³/h
- H: 580 – 1,504 mm

For more solutions and products please visit
www.trox-office-air.com

Miele, Gütersloh, Germany

B2
All-air
CAV

Air-water systems

BEAM

Unilever, Hamburg, Germany

► Energy-efficient air-water systems ►►

Central and decentralised air-water systems have the following advantages:

- **Efficient space utilisation**
  Air-water systems require comparatively low air flow rates, this means that ducts with smaller cross sections are sufficient.

- **Architectural design options**
  Units for installation in floors, ceilings or walls/façades ensure that the best solution for each project can be found.

- **Multi service units**
  Active chilled beams can accommodate services such as lighting, loudspeakers, sprinklers, smoke detectors or PIR sensors.

- **High flexibility with change of use**
  Thanks to the modular configuration of air-water systems it is possible to change the usage of the building at a later stage without changes to the installation.

- **Conservation of existing structures**
  Both central and decentralised air-water systems are used for refurbishments and new builds since they can be adapted to the existing structure and to individual projects.

Ceiling and façade systems perfectly adapted to buildings.
Decentalised systems installed in or near the façade have a number of benefits with regard to design, flexibility and economy. The units allow for noise controlled air handling and provide the shortest possible path for supply air and extract air, i.e. from outside to inside and vice versa. Air-water systems from TROX are usually adapted to a project, to the structure and to the design conditions – in close cooperation with architects and specialist consultants. This is why they offer the greatest possible flexibility and maximum energy efficiency. Since air-water systems need only small air handling units, or none at all, and since pipes require only little space, such systems are often the only – yet ideal – solution for existing buildings that are to be equipped with ventilation and air conditioning components.

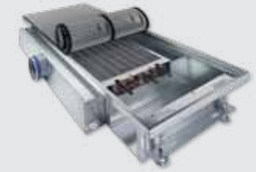
On the next four pages we introduce various all-air systems and give recommendations for product selection.

Examples of air-water systems: active chilled beams, passive chilled beams and decentralised ventilation units

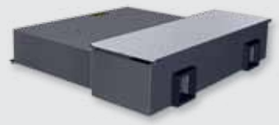
Ceiling
Active chilled beams
Integrated with the ceiling or freely suspended

Wall or sill
Under sill induction units

Floor
Under floor induction units



Decentralised ventilation
- **Under floor units**
- **Under sill units**
- **Vertical units**
- **Ceiling units**



Passive cooling
Passive chilled beams

For more solutions and products please visit
www.trox-office-air.com

Active chilled beam DID632
Primary air:
- 10 – 125 l/s
  36 – 450 m³/h
- L: 893 – 3,000 mm
  B: 593, 598, 618 und 623 mm
  H: 170, 205 mm

Cooling capacity: up to 3,100 W
Heating capacity: up to 2,330 W

Active chilled beam SMART BEAM

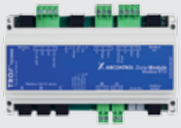
- 8 – 33 l/s
  30 – 120 m³/h
- L: 4,500 – 5,200 mm
  B: 750 mm
  H: 291 mm (plus services)

Cooling capacity: up to 1,000 W
Heating capacity: up to 750 W

VAV terminal unit LVC for low airflow velocities
- 8 – 300 l/s
  30 – 1,080 m³/h
- Ø 125 – 250 mm
  Δp: 5 – 600 Pa

Casing air leakage to EN 1751, class C

Zone control X-AIRCONTROL
can be combined with façade ventilation units to provide demand-based ventilation and extract ventilation and enable the control of the water-side components of the heating and cooling circuits.



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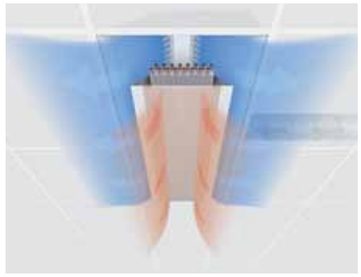
► X-BEAM: Air-water induction units ►►

In rooms where high thermal loads prevail, air-water systems are the energy-efficient alternative to all-air systems. Since they heat or cool the room air with air-to-water heat exchangers, the heating and cooling capacity can be provided independent of the required fresh air flow rate. Air-water systems may be installed 'openly', e.g. not concealed by suspended ceilings; a good example is the SMART BEAM, which was designed by Hadi Teherani. The most common installation, however, is in suspended ceilings.

With **DID active chilled beams** fresh air from the air handling unit is supplied to the rooms in addition to water-based cooling or heating. As the system relies on the principle of induction, the supply air flow can be considerably reduced when compared to all-air systems. No additional fans are necessary to transport the secondary air, which results in less energy consumption and only minimal noise.

Active chilled beams save space because they are comparatively flat and require only a compact air handling unit and smaller ducts. Since they can be operated in both cooling and heating mode, no static heaters are needed. An additional advantage is the fact that lighting, loudspeakers, smoke detectors and sprinklers may be integrated.

Freely suspended active chilled beams from TROX, such as the SMART BEAM, may be visibly installed and are an aesthetically pleasing solution; they can also be combined with component activation.
In addition to active chilled beams, TROX also offers induction units for underfloor or for façade installation.



From left to right: Norwich Union, UK; Charles Avison Building (City Library), Newcastle, UK

TMB Headquarters, Istanbul, Turkey

C
Air-water central

Under sill unit FSL-B-ZAS
Secondary air unit for supply air and extract air, with heat exchanger and heat recovery, for installation under the sill
- up to 47 l/s
  up to 170 m³/h
- B: 1,245 mm
  H: 800 mm
  T: 400 mm

Cooling capacity: up to 760 W
Heating capacity: up to 2,850 W

Under floor unit FSL-U-ZAB is fitted with a removable grille that facilitates maintenance and cleaning.
No condensation is formed thanks to a new control strategy; heat recovery may be used all year round.

Vertical supply air and extract air unit FSL-V-ZAB with heat exchanger and heat recovery
- up to 42 l/s
  up to 150 m³/h
- B: 396 mm
  H: 1,800 mm
  T: 319 mm

For more solutions and products please visit ***www.trox-office-air.com***

▶ Decentralised air-water units for the façade ▶▶

Whether new build or refurbishment, TROX has provided many prestigious projects with façade ventilation systems. This expertise is incorporated in the units for each particular façade.

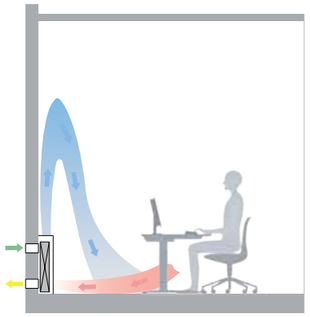
Façade ventilation systems can be installed in ceilings near an external wall, under sills, in floors, but also in a window recess; they are suitable for rooms with an external wall and a depth of up to 7 m. Covers may be bespoke designs or selected from a multitude of available designs such that the units blend in perfectly with the façade.

Integrating decentralised ventilation systems into the building envelope has its advantages:

- No suspended ceilings means a reduction of both costs and building height.
- Flexible installation options, compact dimensions, and the fact that they operate independently from a central air supply make the decentralised ventilation units from TROX the ideal choice for refurbishment projects.
- Water is a more efficient means of transport for energy than is air.

EC fans and an integral heat exchanger for heat recovery prevent the warm room air from being extracted and exhausted unused, thereby increasing the efficiency of the entire system.

Intelligent system.
Air quality and temperature sensors intelligently signal measured values to the units. Supply air and extract air volume flow rates are controlled based on the VOC content, which ensures a constant high air quality. While the air-water systems may be integrated with the building automation system, it is also possible to control each room individually.



Feldbergstraße, Frankfurt/Main, Germany

▶ Air treatment ▶▶

Innovative systems work reliably.

A suitable communication system allows for the efficient, safe and smooth interaction of all building services. The seamless integration of ventilation and air conditioning with the BMS is ensured by control and monitoring systems that provide comprehensive communication and configuration functions and hence a high level of flexibility. When X-AIRCONTROL is installed, room information such as damper blade positions or the heating and cooling energy required may be included in the control of the X-CUBE air handling unit.

▶ Air handling unit ▶▶

TROX X-CUBE air handling units can be individually configured and are hence suitable for a wide range of applications. They can handle volume flow rates of 600 to 100,000 m³/h at an airflow velocity of 2 m/s. X-CUBE units are available as supply or extract air units or as a combination of both. It is possible to arrange several units side by side or on top of each other, depending on the installation location.

X-CUBE technology in a compact unit.
TROX has combined all the advantages of the X-CUBE into a ready-to-operate, pre-configured system that offers the same outstanding quality as the existing X-CUBE yet in the smallest unit possible. Two heat exchangers for volume flow rates of 600 to 6000 m³/h are the ideal solution for small and medium-sized applications, e.g. for supplying an entire wing of a building.

Effective filtration is conducive to health.
The indoor climate affects the comfort, health and performance of room occupants. In this context, the separation of hazardous particles such as dust, pollen, aerosols, gases or micro-organisms from the fresh air by using suitable filter systems is an important aspect.

Recommended filter classes – EN 779

Air quality indoors / outdoors	SUP 1	SUP 2	SUP 3	SUP* 4
ODA 1 – clean	M5 + F7	F7	F7	F7
ODA 2 – dust loaden	F7 + F7	M5 + F7	F7	F7
ODA 3 – highly contaminated	F7 + F9	F7 + F7	M6 + F7	F7

*supply air

For hygienic reasons the fresh air should be filtered in two stages (IDA 1 and 2 to EN 16798-3). In general, only filters correctly marked and tested to EN 779 and EN 1822 must be used.

TROX ventilation fans may be used as decentralised units for the removal of stale air. They are also used as additional fans in ducts. The widest product portfolio available is made in Germany and meets the latest requirements of the ErP directive of the European Union. Plastic and ATEX constructions are also available.

X-CUBE air handling unit

- Special materials
- Smooth internal and external surfaces
- Configurable
- Rapid and easy installation
- Complete condensate drainage due to special stainless steel condensate drip tray
- Easy access to components
- Construction variant with controls package is easily connected to the BMS
- High-quality TROX filters
- High energy efficiency due to heat recovery systems
- Highly efficient EC fans
- Weatherproof construction variant

EUROVENT CERTIFIED PERFORMANCE AHU N° 13.02.005 Range X-CUBE www.eurovent-certification.com

Energieeffizienzklasse A+

TROX high-efficiency filters are tested to EN 779 or EN 1822, fine dust filters of filter classes M5 to F9 are certified by EUROVENT.

EUROVENT CERTIFIED PERFORMANCE AIR FILTERS CLASS M5-F9 www.eurovent-certification.com

X-FANS ventilation fans and performance

Const-ruction	Max. motor rating (kW)	Max. volume flow rate (m³/h)	Max. pressure (Pa)
Axial	230	400,000	4,000
Radial	130	200,000	4,000
Roof	30	55,000	2,300
Duct	12	12,000	1,200

For more solutions and products please visit
www.trox-office-air.com

Safety systems

Fire protection and smoke extract systems

Fire protection and smoke extract are important issues in a comprehensive building design. The prime objective in the event of a fire is to avert danger, i.e. to save lives and to protect property.

This is why TROX gives functional safety top priority in their fire protection and smoke extract systems. TROX components and systems complement each other perfectly such that they fulfil their function reliably in the event of a fire. TROX offers network solutions that link fire dampers and smoke control dampers, which are SIL2-certified and provide overall safety.

TROX fire dampers shut off ducts in the event of a fire and prevent the spreading of fire through ducting. They meet the high requirements of EN 15650 and are CE certified. They are available for various state-of-the-art types of installation such as with a fire batt or flexible ceiling joint.

TROX smoke control dampers in mechanical smoke extract systems are used in one or in several fire compartments to remove hot fire gases and to let in additional supply air. The CE marking according to the Construction Products Regulation means that the product can be universally used in all European countries and for different application situations.

TROXNETCOM communication systems allow for TROX fire dampers to be integrated easily and safely with a BMS or with the X-CUBE air handling unit.

TROX duct smoke detectors increase safety levels since they detect smoke independent of the temperature at a very early stage and trigger the closure of the fire dampers.

TROX smoke exhaust fans effectively remove hazardous hot fire smoke from buildings. The X-FANS product range includes many different fans which (depending on the model in question) are available for temperature ranges from 200 to 600 °C and with an exposure resistance of up to 120 minutes. X-FANS are tested to EN ISO 12101-3, carry the CE mark, and come with building inspectorate approval.

Comprehensive system solutions from TROX ensure functional reliability. Fire and smoke are detected at an early stage such that their spread can be prevented, and people can leave the building on smoke free escape routes.

Dorotheenblöcke, Berlin, Germany

TROXNETCOM links fire protection and smoke extract components to a system and allows for central BMS connection.

TROX fire dampers with CE marking and declaration of performance according to the CPR.
TROX duct smoke detector RM-O-M Multi functional duct smoke detector with volume flow rate and contamination monitoring.
TROX smoke control dampers EK-EU, CE certified according to the CPR, still fully open or close after being exposed to higher temperatures (approx. 800 °C) for 25 minutes.

X-FANS smoke exhaust fans are available for 200 °C, 300 °C, 400 °C and 600 °C.

Various constructions:
- Roof fans
- Axial fans
- Centrifugal fans
- Wall-mounted fans

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Good air with TROX

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TROX® TECHNIK

The art of handling air

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