TROX

life

magazine no. 20

Air + health.

Air is life.

TROX® TECHNIK
The art of handling air *for indoor life quality*

The health aspect behind intelligent air conditioning.

The theme of this edition of TROX life is health – and in these times of the COVID-19 pandemic, it is certainly a topic we cannot avoid. We want you to know that in our reporting, we rely exclusively on independent studies and reliable sources and statements. What is certain is that the risk of transmission can be minimised by effective and modern ventilation technology. The leading associations in the industry, FGK and VDMA, have therefore heavily focused on the requirements for ventilation and air purification of rooms in connection with the rules regarding distancing, hygiene, masks and ventilation, as well as the risks of infection, and have defined clear rules as to under which circumstances ventilation and therefore sufficient protection against infection is provided – depending on the size of the room, the number of people present and their activity. It is just a shame that these really valuable and, most importantly, effective rules and guidelines are not observed by politicians. If more attention were paid to the individual situation in each sector, many restaurant, hotel and gym owners, some of whom have invested a lot of money in modern ventilation systems and therefore in active infection control, could have been able to open their doors a long time ago. And that's regardless of the number of cases!

Perhaps the Indoor-Air trade fair in Frankfurt – originally scheduled for June, but postponed to 7–10 October because of yet more stringent measures and restrictions to curb the coronavirus pandemic – will offer an opportunity to get the HVAC industry's message across to the public: air is an important provision. Good air quality indoors not only increases well-being, but among other aspects also contributes to good health. This makes indoor air quality part of the solution for getting back to normal everyday life. There are already ideas and concepts that work in the ventilation and air conditioning sector – they just need to be implemented.

In this edition you can also look forward to an exciting project report, in which we report on the ventilation and air conditioning equipment in the new 'Haus M' hospital building at Klinikum Karlsruhe. Klimabau, which is responsible for construction, execution, commissioning and maintenance, has worked together with TROX experts to develop a complete air conditioning and ventilation strategy. And the special thing about it is that in addition to TROX, TROX HGI GmbH was also involved in the project and, as a systems supplier, provided all of the control components and control elements for the central building management system – including the connection for all of the building services. In other words: everything from a single source! Last but not least, and true to our mission 'for indoor life quality', maintaining health and well-being is particularly close to our hearts. In this respect, the coronavirus has taught us to think even further outside of the box, and this is why we are in constant contact with scientists and experts. In this issue we even interview two of them: Prof. Martin Kriegel from the Hermann Rietschel Institute on his groundbreaking research results, and Dr. Thomas Voshaar from the Bethanien-Krankenhaus in Moers, Germany, on his experiences as a respiratory specialist during the coronavirus pandemic.

I hope you enjoy reading this issue.

Yours Udo Jung
TROX Board of Management

Innovative approach for the Städtische Klinikum Karlsruhe.

For the first time in our company's history, we had all the strings of ventilation technology in our hands – at Haus M at Klinikum Karlsruhe. We provided every component, from diffusers to the air handling units (X-CUBE). It is now a completely coordinated system – including controls and connection to the central BMS. Everything from support in planning and design to configuration, electronics, system control and overall system acceptance has brought our customers, specialist consultants, HVAC contractors and system owners decisive advantages: fewer interfaces, a faster design process, and faster implementation and acceptance. And in the end, everything came in under the expected budget.

Klinikum Karlsruhe.

The Städtische Klinikum Karlsruhe hospital has been in existence since 1907. Almost half of its buildings – which are made up of a well-proportioned, listed ensemble worthy of preservation – date from this period. As a maximum-care facility providing medical care close to people's homes, it has an important task.

Expansion measures since 2016.

The current infrastructure is no longer up to date. For this reason, extensive structural changes are required and the hospital is rebuilding about one fifth of its usable space. As well as the new construction of the institute building and the refrigeration plant room, the new construction of Haus M, the future ward and functional building, is of particular importance.

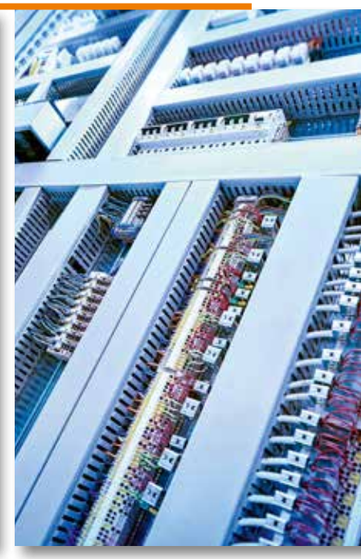
Haus M.

The building is spread over a total of 21,000 m². Across its seven floors, it will house the hospital's intensive care units and the new central operating area with 20 operating theatres. It will also house a central sterilisation unit, a number of examination and treatment units, the extension to the central emergency department, and the general care wards with 240 beds over two floors.

Level 02 houses large plant rooms, especially for the installation of the ventilation systems for the operating and nursing areas, which are installed in four sub-centres. The exhaust air from the ventilation system is discharged via the roof in separately provided outlet structures.

Haus M has 240 beds over 2 floors.

Operating theatre with LF ceiling.



The ventilation plant room on level 02 supplies the entire building complex with air. The flow rate is 32,000 m³/h.

Requested: everything from a single source.

When Klimabau Gesellschaft für lufttechnische Anlagen mbH was awarded the contract for the installation and commissioning of the ventilation and air conditioning systems, including fire protection, as well as the installation of the control technology, the heat recovery systems and the individual room controls for the laboratory area, its engineers had the goal of obtaining the entire air conditioning and ventilation technology from a single source.

Manufacturers have to ensure that building services equipment is easy to use; wiring and addressing for building communication should be as minimal as possible (plug and play), and maximum safety, reliability and functionality have to be ensured. All information strands converge in the central building management system. All system states and changes are recorded and analysed using a monitoring process. This means that the central BMS performs the central information work. As a result, central specifications are transmitted from here to the sub-systems and components, such as the operating mode.

So that the building automation system can understand the signals within the building, components and systems of the trades are connected to the central building management system via bus, in this application via BACnet.

Haus M stands for a perfectly coordinated complete ventilation solution from a single source – from the air handling unit to the control strategy and to the smoke extract systems.

Properly resolving interface issues.

Interface issues were the reason that TROX decided to develop sophisticated solutions for air management and to think in terms of a complete 'ventilation and air conditioning sub-system'. This means that customers receive customised, perfectly coordinated, complete solutions. This enabled our engineers to accompany the consultants and HVAC contractors throughout the entire ventilation path, from the air handling unit to the air terminal device and to complete smoke extraction systems. The benefits are clear – fewer interfaces mean less work required and lower costs.

The positive cooperation during the construction of the new surgical clinic at Heidelberg University Hospital was a decisive factor in the decision to rely on TROX technology once again. Above all, the positive experience with TROX HGI during the joint design and commissioning of the control technology, including its connection to the building management system, was a decisive factor in awarding the contract to TROX.

Haus M has 6 ventilation control centres in which 12 TROX X-CUBEs operate.

Strict requirements for ventilation technology when it comes to hygiene and safety.

Ventilation and air conditioning systems in hospitals must ensure that the contamination of air with micro-organisms is reduced to a minimum and that strict limits are not exceeded. In addition, dust, anaesthetic gases and odorous substances must be contained. This applies in particular to operating theatres, intensive care units, delivery rooms and neonatal units.

Air supply technology for maximum hygiene.

The twelve air handling units including heat recovery are housed in six plant rooms on levels E-2 and E02. TROX X-CUBE air handling units in the main ventilation plant room supply the 21,000 m^2 of Haus M with outside air. The air treatment of the ventilation and air conditioning systems consists of a separate air preheating for filters, heat recovery, cooling coil, heating coil and steam humidifier. The differential pressure of the air filters and the fans is reported to the automation system in an analogue manner. In the building, fire dampers, volume flow controllers and shut-off dampers must be connected and controlled.

Thanks to the installation of the TROX run around coil system (RAC), a regenerative heat recovery system, it is ensured that the air flows are completely separated from each other. This is an important hygienic aspect, as leakage between supply and extract air is neither desired nor permitted. The TROX hydraulic unit, which includes special RAC control, ensures highly efficient heat recovery. Heat recovery efficiencies of up to 80% can be achieved with this system.

As a special feature, additional humidification in the ventilation and air conditioning systems ensures improved well-being for patients and staff, which has a positive effect, especially in the cold season. The supply of fresh air to the 26 operating theatres is optimised with regard to energy efficiency via integral volume flow controllers by mixing in processed recirculated air.

The 380 TROX VAV controllers in various designs and more than 2,150 CAV controllers ensure the correct airflows in the individual supply areas.

Jet fans for the central emergency department.

The central emergency department is connected via the ventilation systems on level 2. Due to the location of the ventilation systems in the western part of the building, the duct routes to the central emergency department span approx. 250 m. For this reason, jet fans are used in the supply and exhaust air ducts at the emergency department's shaft inlet. To ensure supply to the emergency department, the jet fans are set up redundantly. Two jet fans and multileaf dampers are located in each of the supply and extract air branches.

Connection to the building automation.

The building automation system (BACnet automation technology with a total of 58 information focal points (IFP) and 25 further input and output modules for connecting the field devices) controls the ventilation, cooling and heating in accordance with DIN 18382 and DIN 1838 (building automation). The different states are displayed in the on-site BACnet control centre.

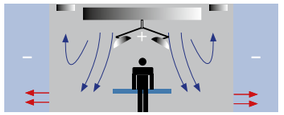
The time required for opening and closing the fire dampers is being monitored and is an indication for predictive maintenance. All fire dampers must be individually switchable from the Direct Digital Control (DDC) as well as from the central BMS. Communication between the automation station and the fire dampers takes place via the ASi network.

Connecting and linking external components such as refrigeration systems, consumption meters, pumps, volume flow controllers, etc. to the control automation system is performed via various bus connections. A total of over 117,000 m of control cable and over 1,600 m of cable trays have been installed. A total of over 15,000 data points are also controlled.

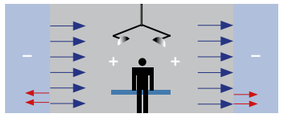
Room classes in accordance with DIN 1946-4 and alternative air distribution systems

Room class Ia

Very high hygiene requirements:
Operations such as transplants, chest and trauma surgery



Low-turbulence laminar flow



Low-turbulence laminar flow

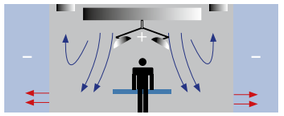
Air supply
- Low-turbulence laminar flow (LF): supply air flows directed from top to bottom (recirculation air)

Air states
- Positive pressure
- Higher air velocities in the centre of the LF
- Supply air temperature lower than indoor air temperature
- 3-stage filtering, min. ePM10 50%, recommended ePM1 60%, ePM1 90%, H13

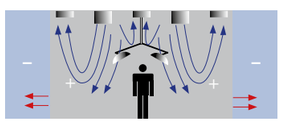
Dynamically shielded protection area

Room class Ib

Increased hygiene requirements:
Recovery rooms, ICU



Turbulent flow



Turbulent flow

Air supply
- Turbulent or mixed flow
- Constant pressure maintenance with respect to subordinate rooms

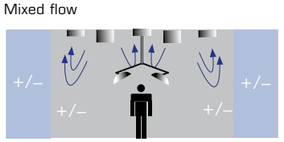
Air states
- Positive pressure
- No separate protection area
- 3-stage filtering, min. ePM10 50%, recommended ePM1 60%, ePM1 90%, H13

Static pressure maintenance

Room class II

General hygiene requirements:
other rooms used for medical treatment, e.g. ENT

Mixed flow



Mixed flow

Air supply
- Air transfer flow or mixed air principle. Room flow with high ventilation effectiveness and rapid removal of any pollutants from the emission source.

Air states
- Air balance depending on the safety objective
- 2-stage filtering min. ePM10 50%, recommended ePM1 60% / ePM1 90%

Air transfer flow / Mixed air

Ventilation technology for operating theatres.

The most critical air hygiene requirements apply in operating theatres. To prevent the risk of infections caused by airborne pathogens, and to ensure that standards of occupational medicine are adhered to, airflow strategy and air filtration, and in particular intelligent control, play an extremely important role.

The main ventilation plant room on level 02, with four supply air and four and extract air systems, provides a low-turbulence laminar flow (LF) via LF ceilings, which dynamically screens off the most sensitive area with the operating and instrument tables (1a requirement). The air is extracted with stainless steel extract units with lint screens at each of the four corners. The supply air for a further eight operating theatres in class 1b is supplied via four ceiling mounted particulate filters (filter class H14).

Pressure conditions prevent infiltration into adjacent rooms.

Operating theatres must only be accessed via airlocks; therefore, ventilation technology provides positive pressure that prevents pathogens from entering from adjacent rooms.

In the three intensive care units as well as in the sterile care and isolation rooms, positive/negative pressure differences, airlocks and effective supply and extract air filtration also ensure isolation from the ‘outside world’.

Fire protection and smoke extract system.

Over 1,200 motorised fire dampers in the building ensure that individual areas are safely closed off in the event of an emergency thanks to intelligent control.

Conclusions.
The comments from the HVAC contractor and the project manager are overwhelmingly positive:

Jochem Nordeweit
Authorised representative of Klimabau GmbH

'Because we were commissioned not only with the ventilation and air conditioning systems for this complex building, but also with the entire building management in cooperation with TROX HGI GmbH, we are able to control it completely and achieve a significantly improved effect for the client. This is because they no longer have to deal with the issues that they would usually have here.'

Markus Riester
Site Manager Klinik Karlsruhe

'We are happy to have done everything in exactly this way because there are fewer interfaces. For this project, it was very important to have a partner in Klimabau for the planning and execution who could also tell us what we need to improve or what we need to do – and who will also take care of the maintenance and servicing afterwards. As the project manager, I'm responsible for making sure we stay within budget and meet the deadlines – and we've done that well.'

System description:
Städtisches Klinikum Karlsruhe – Haus M new building

Total supply air volume flow rate: 320,000 m^3/h
Total extract air volume flow rate: 312,000 m^3/h, plus extract air via individual extract air fans: 21,000 m^3/h total of 13 fans
Air handling units: 12 TROX X-CUBE units in 6 plant rooms
Filters: Ceiling mounted particulate filters with filter class H14
Air supply: 472 H14 ceiling mounted particulate filters in intensive care units and 1b classified operating theatres
Supply/extract air grilles: In addition to the H14 HEPA filter ceiling mounted particulate filters, 890 supply air terminal devices and 1,320 extract air devices are installed in a wide variety of designs (swirl and slot diffusers, grilles in a linear arrangement, lint screens and disc valves).
Fire protection: 1,200 motorised fire dampers, smoke protection dampers and 40 smoke control dampers, as well as fire protection valves and F30 outlets and over 2,500 volume flow controllers.
Ductwork: Around 38,000 m^2 of rectangular ducts and 16,800 m of circular ducts made of galvanised sheet steel, stainless steel V2A and PPs. In addition: For the central sterilisation area on level E01, an extract air system made of PVDF with 3 extract air fans will be installed to connect the cleaning, disinfection and drying machines.

Global refurbishment:
TROX upgrades hospitals.

The coronavirus has a firm hold on the world – which is why it is all the more important to upgrade healthcare buildings in terms of hygiene and ventilation with reliable and efficient concepts, and to refurbish them accordingly. Together with its partners, TROX advises, configures and supports numerous projects in hospitals, treatment centres and vaccination stations around the globe. Customers benefit from the all-encompassing approach: perfectly coordinated systems from a single source, smart control strategies, concepts and solutions including problem-free connection to the building management system, as well as comprehensive advice and support, and just-in-time delivery. Here's an example:

Hospital Infantil Virgen del Rocío, Seville.

TROX España equipped this children's hospital with a fully coordinated system. From air treatment and smart control to air distribution with high-performance HEPA filter systems. In the process, TROX España demonstrated a high degree of individual flexibility. In this way, the configuration of the TROX HEPA filters for operating theatres was precisely adapted to each room by the Spanish TROX factory and perfectly integrated into the architect's interior design plans.

Two representatives of the Andalusian regional government used the opening of the clinic for an informative tour with the clinic's doctors: Minister of Health Jesús Aguirre (2nd from left) and President Juanma Moreno (3rd from left).

SPAIN

HEPA filters blend harmoniously into the architectural room design with individually created ceilings.

Air handling units: TKM 50 HE, equipped with UV lights
Filters: HEPA filter F680 units, MFP-H14, TFC, MFP-H13
Volume flow controllers: TVR, TVR-SAT 1200 EASY and TVJ-EASY, RN and VFL
Sound attenuators
Smoke control dampers: FKA2-EU
Multileaf dampers: JZ-LL
Air terminal devices: VDW

Opening safely instead of blanket closures.

FGK and VDMA publish a procedure for assessing ventilation-based infection control.

The leading associations in the industry have been working tirelessly on the requirements for ventilation and air purification of rooms in connection with the distancing, hygiene, mask + ventilation rules and the corresponding infection risks during the COVID-19 pandemic. Status Report 52 from the Fachverband Gebäude-Klima e.V. (FGK – Building Climate Association) 'Requirements for ventilation and air purification to reduce the risk of infection via airways – distancing, hygiene and masks + ventilation' and the procedure explained therein is supported by the VDMA, as it allows a differentiated assessment and, hence, use of rooms in a way that is suitable for infection control.

The FGK's Status Report – which forms the basis of the VDMA's information letter – describes, on the basis of European standards regarding infection-control-compliant ventilation, a procedure for designing and assessing ventilation-based infection control indoors.

Whether the addition of ventilation and therefore sufficient protection against infection is given depends on the size of the room, the number of people present and their activity. The basis for this is the indoor air quality categories described in DIN 16798-1. If we compare the requirements of these categories with current studies, it becomes clear that Category I plus an activity factor leads to sufficient ventilation-based infection control. The fact that, according to experts, CO_2 levels below 800–1,000 ppm equate to sufficient ventilation-based infection control also fits the requirements of Category I. The addition of an activity factor is necessary because both physical activity and speaking behaviour significantly influence aerosol emissions from people.

Therefore, according to the FGK's procedure, + ventilation is fulfilled if, on the basis of the above-mentioned standard, Category I plus an activity factor is provided.

It should be noted that required fresh air quantities are determined according to DIN EN 16798-1, but with regard to infection control, the same effect can be achieved with purified air. Therefore, the term 'virus-free air' is used in the FGK procedure. If a minimum outside air volume of approx. 20 m³/h per person is observed, the additional volume flow required for Category I can be achieved using an air purifier. It is important to note that the 20 m³/h should only be seen as the absolute minimum with regard to infection control. For good indoor air quality beyond infection control, significantly higher outdoor air volumes are recommended.

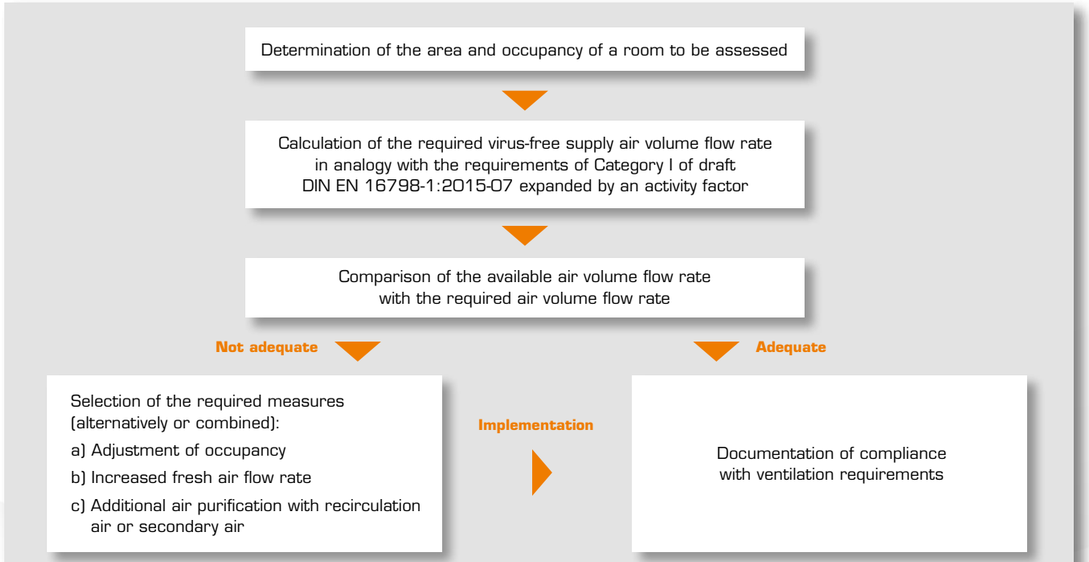
As an example, a seminar room (75 m², 25 people) is considered. According to DIN EN 16798-1, this results in a minimum outside air volume flow of 1,170 m³/h for Category I. To meet the + ventilation requirement, this can then be provided either entirely via a mechanical ventilation system or partially via air purifiers, as long as the above-mentioned minimum outside air volume of approx. 20 m³/h per person is maintained.

If + ventilation is not fulfilled in a room on this basis, there are three possible measures that can be taken to ensure that the + ventilation requirement is still achieved for the room:

- Reduction in occupancy
- Increase in fresh air flow
- Additional air purification

This finally gives the '+ ventilation' requirement a clear and concrete definition. Legislators have added the ventilation requirement to the generally accepted rules of distancing, observing hygiene standards and wearing a mask in everyday situations. With the assessment procedure now available, it is now easy to assess whether or when this + ventilation requirement is fulfilled. This would allow applications to be fully assessed for distancing, hygiene, mask + ventilation rule compliance and avoid blanket closures.

The principles of successful assessment and verification of proper ventilation, i.e. ventilation in line with infection control requirements.



The diagram shows the simple method for evaluating ventilation practices according to Status Report 52.

These three examples show us what could be possible:

A **gym** with 30 people, 120 m² and a ventilation system with 2,000 m³/h outside air does not initially fulfil the + ventilation requirement, but can eventually fulfil this requirement by means of one of the following measures and, if the distancing, hygiene and mask rules are complied with, can be considered sufficiently safe with regard to ventilation-based infection control:

- Reduction of occupancy from 30 to 22 people
- Increase in airflow from 2,000 m³/h to 2,420 m³/h
- Additional air purifier with H13 filter and a volume flow rate of 420 m³/h

A **theatre** with 1,000 people, 1,000 m² and a ventilation system with 20,000 m³/h outside air does not initially fulfil the + ventilation requirement, but can eventually fulfil this requirement by means of one of the following measures and, if the distancing, hygiene and mask rules are complied with, can be considered sufficiently safe with regard to ventilation-based infection control:

- Reduction of occupancy from 1,000 to 455 people
- Increase in airflow from 20,000 m³/h to 39,600 m³/h
- A number of additional air purifiers with H13 filters and a volume flow rate of a total of 19,600 m³/h

A **restaurant** with 50 people, 100 m² and a ventilation system with 2,000 m³/h outside air does not initially fulfil the + ventilation requirement, but can eventually fulfil this requirement by means of one of the following measures and, if the distancing, hygiene and mask rules are complied with, can be considered sufficiently safe with regard to ventilation-based infection control:

- Reduction of occupancy from 50 to 32 people
- Increase in airflow from 2,000 m³/h to 2,808 m³/h
- Additional air purifier with H13 filter and a volume flow rate of 808 m³/h

Natural or mechanical ventilation – a study from RWTH Aachen clarifies the situation.

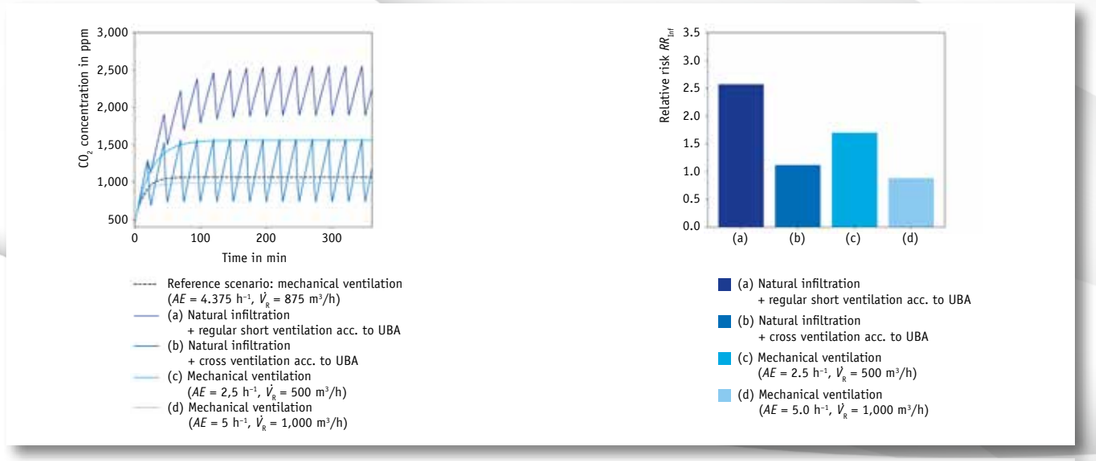
RWTH Aachen has published a study in which infection risks are calculated for specific applications and the influence of mechanical and natural ventilation as well as of mouth and nose coverings and air purifiers is assessed.

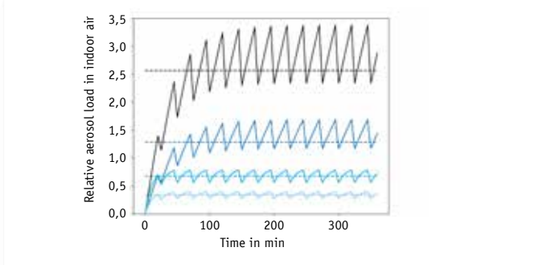
When assessing infection risks, the absolute risk of infection is first determined for a mechanically ventilated reference classroom.

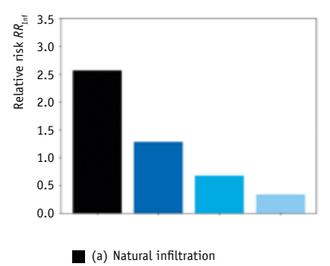
Framework conditions of the reference classroom: 200 m², 1 school lesson of 60 minutes, 25 seated people, 1 of whom is speaking, controlled mechanical ventilation (outside air supply and extract air removal), outside air and extract air volume of 35 m³/h per person (total 875 m³/h > air exchange rate 4.4h -1).

The calculation of absolute infection risks is currently still fairly uncertain because not all medical framework conditions are clear. In the study, the absolute risk of infection was therefore estimated based on known associations and previous studies for the reference classroom. The assumptions required for this were determined based on real, known infection events related to SARS-CoV-2.

For this situation, according to the study, there is an absolute risk of infection of 1% if one of the 25 people in the room is infected. The probability that one of the 25 people in a classroom is infected is about 9% for 300,000 infected people in Germany (more accurately, infectious people). Therefore, the overall probability of meeting an infected person in this scenario and becoming infected is only 0.09% for this well-ventilated scenario.







Source: RWTH Aachen _ DOI: http://dx.doi.org/10.18154/RWTH-2021-02417 [dx.doi.org]

To compare mechanical and natural ventilation, the German Environment Agency's (UBA) ventilation rules (ventilate for 5 minutes every 20 minutes) are compared with the reference classroom and other mechanical ventilation solutions in terms of the resulting CO_2 levels in each case. The aim is to stay below the said 800-1,000 ppm. With mechanical ventilation systems, this is guaranteed all day with typical dimensioning. With natural ventilation, after opening the window(s) fully, but regularly, for a short time, this value is already clearly exceeded in the first hour; with longer observation periods, the values are more than twice as high. According to the study, even with cross ventilation (windows on opposite sides of the building) in accordance with the instructions of the German Environment Agency, it cannot be guaranteed that the level in school classrooms will fall below 800-1,000 ppm. For the first type of natural ventilation, the RWTH staff assume 4 fully open windows and 4 open skylights as well as a 15 K temperature difference. Cross ventilation demands the same on two opposite sides and open doors.

According to the UBA, the risk of infection is 2.5 times higher with regular short ventilation (fully open windows) than with normal mechanical ventilation.

As neither mouth and nose covering nor air purifiers reduce CO_2 levels, the RWTH always presents the relative aerosol load of indoor air for the influence of these measures in addition to window ventilation scenarios. According to the UBA, wearing a mouth and nose covering additionally halves the relative aerosol exposure compared to natural ventilation with regular short full opening of the windows, and an air purifier (500 m³/h), which was still quite small in the study, even quarters it. If both are used in addition to regular short natural window ventilation, the smallest level is achieved. With regard to infection risks, mouth and nose coverings therefore additionally lead to the risk being around halved, and air purifiers lead to it being around quartered.

RisiCo – the freely accessible calculation program from RWTH Aachen.

RWTH Aachen makes it possible to predict the relative risk of infection via aerosols indoors. The effectiveness of air exchange, community mask wearing and air purifiers can be calculated at: risico.eonerc.rwth-aachen.de

Conclusions.

1. Fresh air supply, activity factor and number of people determine the risk of infection. Based on these parameters and the described ventilation options, a room-based assessment of the ventilation can be made, on the basis of which measures can be implemented, if necessary. This means that the spaces could be opened taking into account distancing, hygiene and mask rules.
2. The best system that is also least susceptible to faults is a mechanical ventilation system with a high proportion of fresh air.
3. Adequately dimensioned secondary air purification units significantly reduce the risk of infection in rooms and offer a good, quick and simple solution as an additional measure to natural ventilation.
4. Window ventilation alone only achieves sufficient protection against infection in ideal conditions, which are unrealistic in practice. It also increases heating costs and has a negative effect on the well-being of people in the room due to draughts and noise influences from outside.
5. Well-dimensioned mechanical ventilation systems provide sufficient protection from infection, are energy-efficient, ensure noticeably good indoor air quality, and do not restrict the people in the room in any way.

Industry outlook for ventilation and air conditioning.

The coronavirus pandemic has had a lasting impact on the global economy. Experts expect a decline of 9% in the economic performance of our industry in Germany.

However, there have also been some winners during the pandemic: the food trade, the toilet paper industry, online retailers, etc. The ventilation and air conditioning industry must also explore its opportunities and expertise to take advantage of the aspect of air quality, especially from the point of view of avoiding contagion risks.

The HVAC industry is coming through the pandemic quite well because it is certainly providing positive impetus for modern air conditioning and ventilation technology. The airborne infection risk draws particular attention to air exchange rates and effective ventilation of buildings. It is important for the industry to focus on innovative products and solutions, as well as convincing sales arguments.

Which areas of application will be in particular focus?

Office buildings, airports and shopping centres will lose out in terms of construction volume because major construction projects will be postponed due to the pandemic. Very surprisingly, construction projects in the hotel sector have increased. Hospitals, educational institutions, etc. will become more important for the industry. Generally speaking, with the pandemic, the issue of ventilation becomes more important.

Focus on schools.

Educational institutions are a particular focus for public investors because pupils are crowded into the classrooms there, because to ensure sufficient spacing, capacities would have to be doubled, and because there is a lack of adequate ventilation technology that could significantly reduce the risk of infection and ensure that teaching could continue.

Ventilation and air conditioning technology – opportunities for the industry:

- Trend towards secure and well thought-out solutions; growing insight to invest in smart system solutions.
- The focus is on high-quality HEPA filters for the separation of the smallest particles, such as viruses and bacteria.
- Turning to smart control systems that provide healthy, effective and efficient ventilation – with sufficient fresh air supply and targeted removal of contaminated air.
- In the long term: increase in mechanical ventilation systems in buildings that house many people.
- Upgrading existing systems with smart control technology for demand-oriented ventilation and air conditioning.

High-quality HEPA filter systems ensure the separation of the smallest particles, such as viruses and bacteria.

The patented control system is similar to the WLAN principle and makes it possible to route radio signals wirelessly through the ventilation ducts. Retrofitting offers a unique opportunity to significantly increase efficiency in existing buildings and to noticeably reduce the risk of infection through suitable measures. And with minimal installation effort.

It is important to take advantage of these opportunities, especially since the quality and sterility of the air are hugely important factors when it comes to avoiding the risk of infection.

Ventilation in classrooms.

In the discussion about effective ventilation and air conditioning equipment for classrooms, the retrofitting of central and decentralised ventilation units or room air purifiers is increasingly becoming a focus point. The same applies to the use of high-quality filters that ensure healthy air in classrooms (see also p. 54).

Demand-based control.

Demand-based control should not only be seen from the point of view of efficiency as it ensures demand-based air supply. A smart control system also ensures a controlled and ultimately essential sufficient air exchange.

The air conditioning systems in old buildings do not usually have smart control systems that ensure a demand-based supply. TROX has developed a solution that makes it possible to equip existing systems with smart control technology: RadioDuct.

Industry recommendations for operating ventilation and air conditioning systems.

- Increase fresh air flow rates as much as possible.
- Reduce recirculated air in favour of fresh air.
- Minimise air transfer flow between different usage units.
- If possible, use filters with higher filtration efficiency in recirculation and secondary air.
- Control room air humidity
- Retrofit variable volume flow controllers to concentrate airflows on areas of use.

Minimum value for humidity.

Studies show that a relative humidity between 40 and 60% is optimal when it comes to fighting the spread of respiratory infections such as the flu or even COVID-19. ‘It is in this humidity range that the immune system functions most effectively and viruses are quickly deactivated’, explains Dr. med. Walter Hugentobler, co-author of a Yale study.

The highs and lows of general ventilation technology.

Incoming orders in general ventilation technology fell by 24% in real terms in 2020 compared to the previous year. However, as incoming orders were still slightly positive in the last quarter (+ 2%), this has resulted in a decline in orders of ‘only’ 4% for 2020.

Booked orders are helping companies in the general ventilation industry through challenging pandemic times – at least so far – thanks to good production utilisation in many companies.

Forecasts for mechanical engineering.

The VDMA forecasts production growth of 2% for 2021. ‘Incoming orders in the German mechanical engineering sector fell by 16% in real terms in the first seven months of 2020, while production was 14% below the previous year’s figure’, says VDMA chief economist Dr Ralph Wiechers. ‘For 2020 as a whole, we assume a production decline of 17%’.
Source VDMA, FGK.

500 million for retrofitting public spaces.

The German Ministry of Economics intends to initiate a support programme worth €500 million to subsidise the retrofitting of ventilation and air conditioning systems in the public sector as well as in shops and restaurants with 40% of the costs, thereby increasing protection against infection. The state of Bavaria, in turn, will support the installation of ventilation systems and CO_2 traffic lights in schools and childcare centres with €50 million.

Breathing clearly and healthily.

We breathe automatically, an action that is controlled by the autonomic nervous system – usually without thinking about it. Learning to consciously control breathing can heal the body and mind.

6 x → 4 sec.

Slow paced breathing.

Thomas Loew, who has been lecturing in psychosomatic medicine since 2001, was awarded the Continentale Promotional Prize for Naturopathic Medicine in 1994 for a prospective, randomised controlled study on a relaxation technique. Thomas Loew calls it slow paced breathing. In everyday life, we breathe in and out ten to twenty times per minute. According to Loew's method, it is about six times: in for four seconds and out for seven seconds. This tricks the body into thinking that it is in a relaxed situation similar to deep sleep – and it believes it.

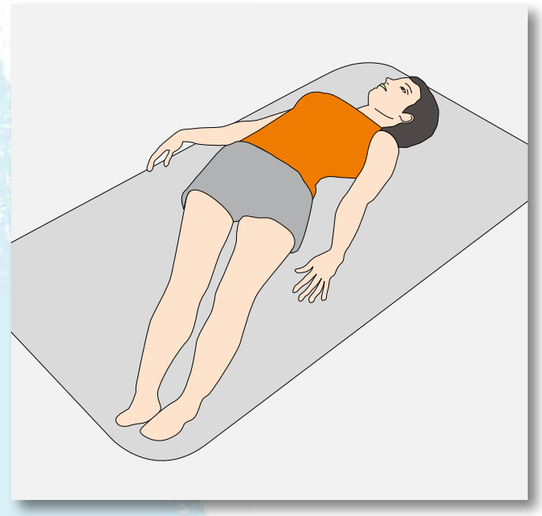
According to Loew, slow paced breathing has a positive effect on high blood pressure and panic attacks. And it should make life easier for patients suffering from migraine, lung diseases or asthma.

Breathing therapy can reduce lung damage caused by COVID-19.

COVID-19 patients who have to be treated in hospital suffer from impaired lung function. Severely ill patients have to be artificially ventilated because their lungs are inflamed and the respiratory muscles are weakened. Breathing therapy is therefore an important aspect on the road to recovery. The aim is to reoxygenate sections of the lungs that are poorly ventilated and to improve gas exchange.

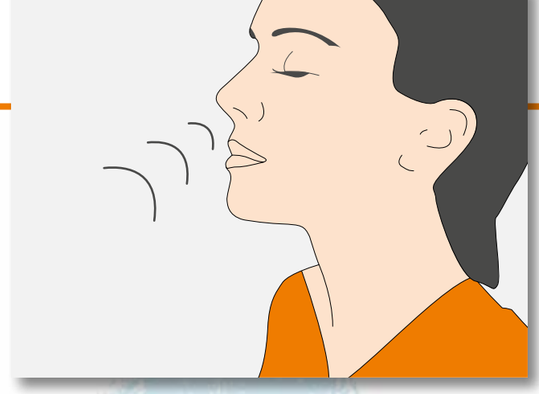
Training methods for effective breathing therapy.

Stretching positions such as the half-moon position or the twisting position are intended to make shortened muscles longer and the lung tissue more elastic. Lying on your back, the upper body and the closed legs are brought to one side so that the body forms a half-moon shape. It should be held for 5 to 15 minutes, first in one direction and then in the opposite direction.



Breathing techniques.

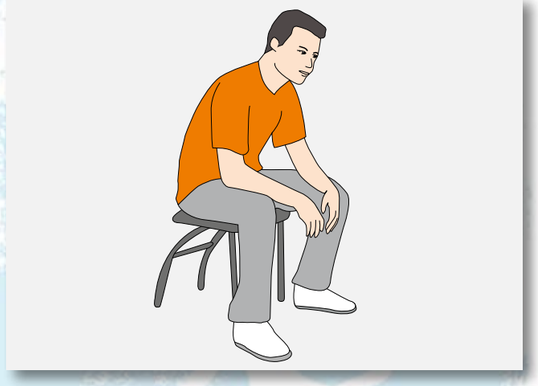
Sniffling inhalation strengthens the diaphragm. Inhale through the nose, in a sniffing manner, by drawing in the air forcefully three times. Then blow the air out slowly and evenly.



The nasal fork grip controls the urge to cough by changing the pressure when inhaling and exhaling. The nostrils are slightly constricted with the fingers. Holding your breath for a short time in the inhalation position (two to three seconds) helps to improve air distribution in the airways.

Positions such as the seated (cart driver) position and the goalkeeper's position are intended to ease breathing under stress and shortness of breath by expanding the chest.

In the seated (cart driver) position the upper body is bent far forward, the forearms are supported with the elbows on the thighs.



In the goalkeeper's position the legs are shoulder-width apart and the upper body is bent forward. The hands are supported on the thighs just above the knees.

The durable TROX X filter mask: The answer to disposable masks and growing mountains of rubbish.

We have all experienced it – while masks were scarce at the beginning of the coronavirus pandemic and not enough were available, even for healthcare workers, just a short time later they characterised the scenery on the streets: discarded, lost, dirty and mostly used. Visually, hygienically and environmentally this is a disaster – and therefore an incentive for TROX to develop a different, unique mask together with the Essen fire department.

The TROX X filter mask has been tested according to the test principle for the SARS-CoV-2 virus and has been registered with the market surveillance authority of the Düsseldorf district government. It has a highly efficient replaceable filter medium that can be used for several applications – and can be washed up to 80 times (according to RKI guidelines: 60 minutes at 60°C and 60 minutes with chemicals). This makes it both reusable and flexible to use. It is also a sustainable alternative to surgical and FFP2 masks, which are often designed as disposable products.

Since March 2021, masks must additionally be certified as FFP2 or FFP3 protective masks in accordance with the European standard EN 149, according to a decision of the market surveillance authority. This certification process is currently underway. In the penetration test, the TROX X filter mask achieves a peak value of 0.27% – and thus even surpasses FFP3 masks (limit value for FFP3 = 1%, FFP2 = 6%).

The TROX X filter masks are produced in the TROX factory in Goch.

Breathing properly under a facemask.

You should not breathe deeply when wearing a mask because this can lead to hyperventilation. Calm and shallow breathing makes it easier to wear a mask.

Conclusions.

The right techniques and exercises make breathing easier, they improve the supply and dispersion of oxygen in the lungs and thus serve a preventive purpose. Basically, if you breathe through your nose, you breathe more calmly and slowly. A distinction is also made between abdominal and chest breathing. With abdominal breathing, the abdomen bulges outwards and retracts again when you exhale. With chest breathing, the chest expands. The important thing to remember is, whether chest or abdominal breathing, let the breath flow freely and relaxed in your own rhythm.

In the interview, Dr Thomas Voshaar comments on the aspect of artificial ventilation for COVID-19 patients (p. 44).

In conversation with Prof. Dr.-Ing. Martin Kriegel.

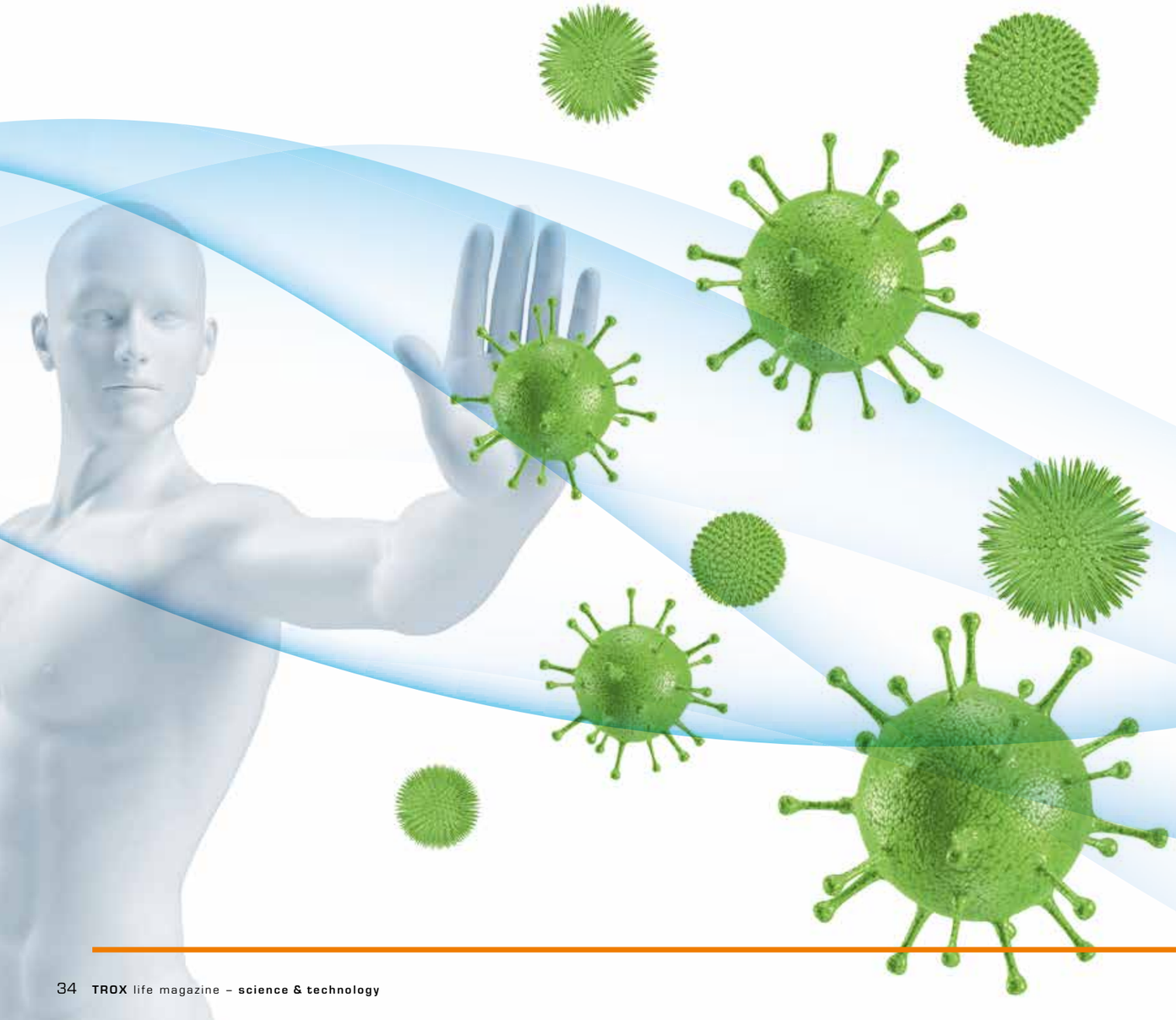
About the optimisation of indoor air flow concepts.

Prof. Dr.-Ing. Martin Kriegel is one of the most renowned scientists in the field of energy technology. One of his research focuses is on the energy-saving potential in air conditioning and ventilation technology.

Professor Kriegel, in 2015 TROX life reported on your research project 'EnEff: Clean rooms'. It would be great to talk about this again.

Ventilation and air conditioning systems in clean rooms have a huge energy demand. Our aim is to find out how much we can reduce volume flow rates and hence reduce energy consumption to a minimum without impairing the protective effect of the airflow.

Knowledge about the behaviour of indoor airflows has still not been researched sufficiently; in particular, the complex interaction of different flow forms in clean rooms is largely unknown. There are also no scientific studies on how clean rooms can be ventilated in an energy-saving way.



For this reason, we installed a research lab that covers approximately 90% of all types of real clean room situations. The aim was to define energy-efficient ventilation concepts for clean rooms with reduced air volume flows, which meet the high requirements for freedom from germs and dust and achieve thermal comfort.

What were your expectations?

We projected a potential energy saving of up to 40%. In Germany alone, the savings would be equivalent to the entire electricity consumption of Portugal, as there is a very high energy demand for clean rooms and many processes take place under clean conditions.

Have you already been able to draw initial conclusions from your studies?

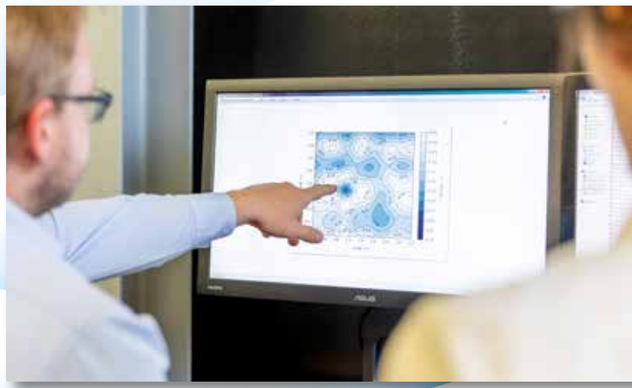
The project has now been completed. The main findings that we were able to draw from this have flowed into two doctoral theses, among others. Firstly, we now know very well how high the supply air velocities actually have to be in a low-turbulence flow from above in order to directly remove the impurities emitted by a heat source without them spreading to the side. This meant that we were able to replace the blanket approach of 0.45 m/s with a new calculation rule. This alone can save up to 70% energy.

On the other hand, very different ventilation effects occur in mixed flow ventilation depending on the arrangement of supply and extract air, and short-circuit flows occur. With an optimised arrangement, up to 80% energy can be saved here.

Local ventilation strategies are also very effective. This means that the entire room is not considered to have the same cleanliness level, but only the requirement zone is ventilated in such a way that the cleanliness requirements are met there. However, there are many influencing factors that must be taken into account in order to achieve a stable protected area.

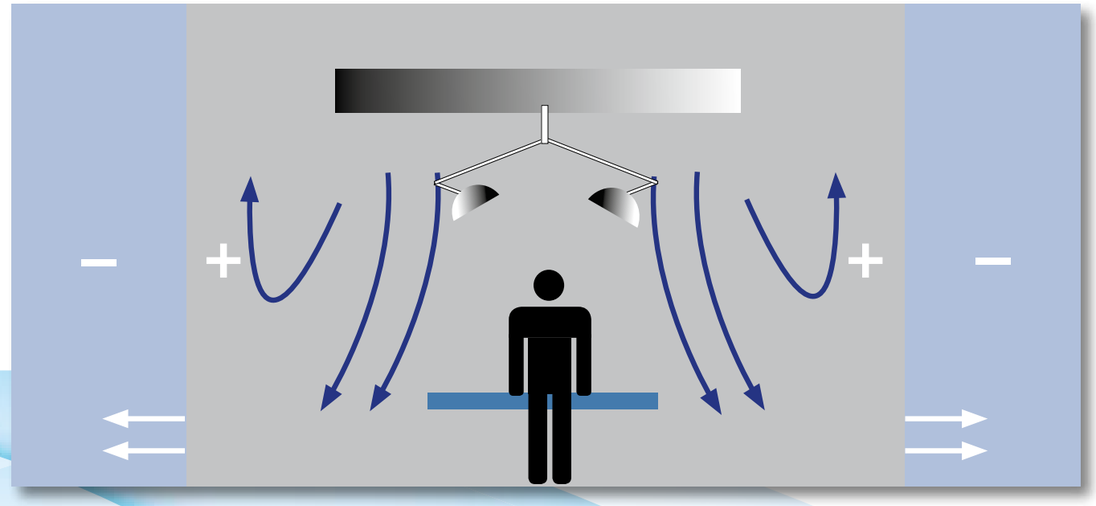
The research team prepares the test laboratory to analyse the course of the airflows.

The operating theatre staff are a source of heat in the room, and also a source of germs. This must be taken into account in the measurements.



Analysis of the acquired measurement data.

Low-turbulence laminar flow



In addition to the clean room and various room air flow laboratories, you have reconstructed an operating theatre in your institute and investigated how the stability of laminar or low-turbulence airflows can be maintained under the specific influencing variables.

That's right. This is one of the follow-up projects to the 'EnEff: Clean rooms' research project because it is a special application of low-turbulence laminar flow (LF). The heat sources (e.g. the operating theatre staff) in the room are also sources of germs, and there must be sufficient airflow velocity coming from the ceiling to displace these contaminants. However, generally, the surgical lighting is in the flow path and causes a disturbance of the vertical flow.

The replica operating theatre, which simulates real-life conditions.

In the standard (DIN 1946 Part 4) for the design of ventilation in operating theatres, among other things, a protective area is described, although this does not exist in reality. On the one hand, this is due to the fact that the operating theatre staff emit harmful germs from the facial area and not on the floor as in the standard acceptance procedure, and, on the other hand, to the fact that the staff themselves and the operating theatre luminaires represent flow obstacles, which create recirculation areas at the wound area itself, thus promoting germ entry. It turned out that despite a 100-fold change of air compared to mixed flow ventilation with one third of the air volume, the same concentration of germs occurs in the vicinity of the wound area. Of course, this is not a plea for mixed flow ventilation, but simply shows that a very high ventilation effort is made here, although this does not lead to the goal of a virtually sterile area.

In addition to the conventional ventilation concepts of mixed flow ventilation and LF, displacement ventilation and innovative local ventilation strategies are currently being investigated using both measurement technology and numerical flow simulation. What has already become clear is that all other conventional concepts have advantages and disadvantages, depending on the requirements and the prevailing boundary conditions. In some cases, very high germ concentrations will occur despite high airflows. Only the innovative local ventilation concepts can practically create a virtually germ-free zone in the wound area.

And this can lead to considerable energy savings in operating theatre ventilation systems?

In actual fact, we assume a savings potential of approximately 70% compared to the currently favoured LF solution.

Can your conclusions also be applied to other non-residential buildings?

The operation of buildings in Germany accounts for around one third of the total energy consumed annually. Conversely, this means that there is huge potential for energy savings in this area. Rooms with special hygienic requirements or the need for low/no particulate matter can be found in many branches of industry, but these requirements can often only be met with a very high level of engineering effort.

In general heating, ventilation and air conditioning technology (HVAC), we therefore attack at several points, which we can transfer from the special knowledge gained in clean room technology, what is known as the supreme discipline for HVAC. On the one hand, this is the optimisation of the system technology, in the area of fast, demand-based control with maximum precision and, in particular, the interaction of the individual components as an overall system. To this end, we are increasingly using machine learning processes to get to grips with the diverse and really individual dependencies.

On the other hand, we look at it from the use side. Here, it is primarily innovative heating, ventilation and air conditioning concepts that aim to provide people with a comfortable and healthy indoor climate, depending on time and also location. This means that not every room point receives the same room condition, but only where people are also present. This goes far beyond the principle of displacement ventilation. We develop solutions in several stages in this area that can be implemented in the short or medium term. There are also a number of visionary concepts that aim to give each person in the same room their own individual room climate.

How high do you estimate the savings potential to be?

It is not only about energy that can be saved through the efficiency of technical installations. Instead, the focus must be on the interaction of all the variables influencing the energy demand of the building – when it comes to planning and operation. The building itself, i.e. the building physics, cubature and façade, can make a very decisive contribution. Unfortunately, colleagues in architecture in practice and in education have, for the most part, not yet understood this. We watch this in horror in our training at the university, where we train about 200 architecture students in building services every year at the Hermann Rietschel Institute. They are not made aware of the topic of energy-efficient building by their professors.

The second essential aspect besides the technical installations are the building users themselves. We are all not geared towards saving energy. It should be a much bigger issue in families, in nurseries, in education. No matter how good the buildings and technical systems are, the rebound effect will eat up the potential savings. Work is being done on smart self-learning control systems. However, it will take a very long time before this is operational across the board and replaces the laziness and ignorance of the users in the end. We are all tasked with stopping climate change. Otherwise things will be far more serious than the current pandemic. This is something experts in the field agree on.

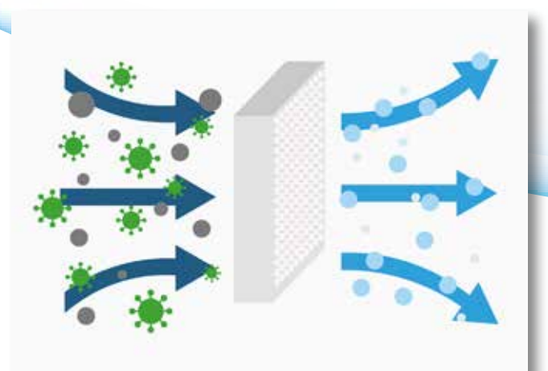
As well as energy efficiency, well-being plays an important role. After all, we know that a sufficient supply of filtered fresh air into rooms promotes not only a feeling of well-being but also boosts performance and reduces the transmission of diseases. Where do you see promising optimisation of ventilation concepts?

I am currently pushing more and more towards the fact that building energy efficiency should be understood differently than before. Building energy efficiency is usually understood to mean that a building is particularly efficient when it consumes little energy. However, this very often leads to losses in thermal and hygienic comfort. We should make sure we are aware of what we are actually building for: for the occupants, primarily to protect them from the elements, but also to create a comfortable environment for them that does not make them ill. Energy is expended for these basic human needs. If we now take efficiency seriously in the definition of the term, efficiency = benefit/effort, then building energy efficiency (GEnEff) could be defined as GEnEff = indoor environmental quality / energy expenditure. Indoor environmental quality (IEQ) includes all forms of comfort, but above all thermal and air quality.

We are not starting from scratch with the whole HVAC issue. The systematic scientific study of the topics and thus the development in this field began over 130 years ago with our namesake Hermann Rietschel. We have many, very good solutions on the market, but they also need to be used more. Unfortunately, there is a trend towards low-tech, which is often understood to mean that in many cases we don't actually need ventilation and air conditioning technology. I think this is completely wrong, as the ongoing pandemic has impressively revealed.

You were one of the first to study the spread of aerosols, carriers of viruses.

Well, there were many before my time who were looking at it. At HRI, we have had a research focus on airborne contaminants in buildings since my appointment. Here we work on a great many projects that always deal with the dispersion and sedimentation of aerosol particles. The studies are carried out both experimentally and by means of numerical simulations. Within the framework of such mostly interdisciplinary research projects, we have established cooperations with the Robert Koch Institute and the Charité – Universitätsmedizin Berlin, among others, which are very exciting and beneficial.



HEPA filters clean the air of over 99.95% of viruses.

What do your findings mean for school openings, for example?

Aerosol particles spread everywhere in the room within a few minutes, with or without ventilation. To remove them from the room, you need effective ventilation, preferably mechanical ventilation.

Realistically, you cannot make a high-quality clean room out of a classroom, so the particle count can only be limited with the conventional ventilation forms of mixed flow or displacement flow ventilation. As it is unknown where an infected person is, it is particularly difficult to respond with local ventilation concepts. The position of the supply and extract air has a decisive influence on the ventilation effectiveness (contaminant removal effectiveness). The only thing left to do is to keep the amount of virus-free air supplied as high as possible in order to keep the concentration of virus-laden particles that an infected person continuously emits low. Furthermore, since virus-laden particles remain in the air, the length of stay should be reduced. And one thing is clear: the longer you stay in a contaminated room, the more likely you are to become infected.

Prof. Dr.-Ing. Martin Kriegel

PROFILE

2001	Diploma in building services engineering at the Technische Universität Berlin.
2005	Doctoral degree.
From 2005	Project leader and deputy managing director at an engineering firm.
Since 2011	Head of the Hermann Rietschel Institute at the Technische Universität Berlin and Professor.
Since 2013	Head of the Institute for Energy Technology at the Technische Universität Berlin.

Air and health.

Fine dust particles in the outdoor air have been proven to endanger health. There is evidence that high levels of particulate matter increase the risk of developing dementia, Parkinson's disease, epilepsy or migraine, or suffering a stroke.

There's danger in the air. Air pollution and health.

A threat to health does not only result from the danger of being exposed to viruses indoors or being restricted in performance due to excessively high CO_2 levels. The increasing pollution of the outdoor air in many places leads to respiratory diseases and to an impairment of the cardiovascular system.

According to cardiologist Thomas Münzel, the RNA of SARS-CoV-2 was detected in fine dust samples from northern Italy. He published a study in the journal Cardiovascular Research suggesting that about 15% of COVID-19 deaths are due to air pollution. 'When prolonged exposure to air pollution and infection with the virus come together, we have an additive adverse health effect, with greater susceptibility to COVID-19', Münzel said. *

**Source Spiegel*

According to calculations by the Centre for Research on Energy and Clean Air (CREA), air pollution leads to 4.5 million premature deaths per year worldwide and causes annual costs of $2.9 trillion (about €2.7 trillion). For China alone, the number of dead is put at 1.8 million, for India at one million. The cost of air pollution worldwide per day is put at $8 billion (about €7.3 billion), which is about 3.3% of global economic output.

The greatest drop in CO_2 for at least 60 years due to coronavirus.

Measures taken by many countries to contain the coronavirus pandemic have drastically reduced global carbon dioxide emissions – at times by up to 17%. In Germany, the decline was even higher at 26%. These are the key findings of a study by 13 international climate researchers, published in the scientific journal Nature Climate Change.

According to the European Environment Agency (EEA), the pandemic has also improved air quality in Europe, with reductions of up to 60% in pollutants in many European countries.

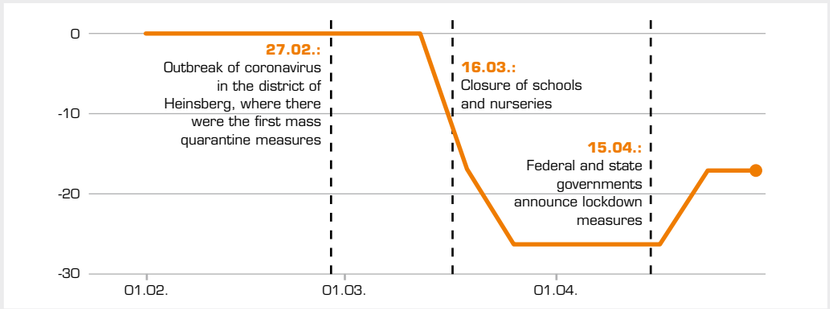
But the targets are necessarily set higher.

The 'Air quality in Europe – 2019 report' analysed air quality in Europe from 2000 to 2017. The study reviewed progress according to the EU Air Quality Directive and its Air Quality Guidelines.

Particulate matter (PM) concentrations continued to exceed EU limits in a large proportion of countries: in 22% of the 2,886 monitoring stations, in 17 of the 28 EU countries at the time, and in 6 other countries that also reported.

Shut down

CO_2 emissions in Germany (change in % compared to normal level)



Source: Le Quéré et al. Nature Climate Change 2020; Global Carbon Project [DER SPIEGEL]

The particulate matter ($PM_{2.5}$) concentrations above the annual limit were measured in 7% of EEA member states (corresponding to 7 countries) and in 3 others participating in the study.

The long-term target of PM_{10} was exceeded in 51% of the monitoring stations and in all states that reported except Estonia, Ireland, Finland and Norway. 17% of the urban population is exposed to particulate matter (PM_{10}) above the set limit and 44% to pollution above the stricter WHO target.

As far as $PM_{2.5}$ pollution is concerned, 8% of EU countries were above the limit and about 77% had air pollution above the WHO target.

So we are still a long way from achieving the WHO and EU targets, and from the decisions of the world climate conferences.

Nevertheless, according to a new study, Europe's air is getting cleaner.

Air quality on the continent has improved noticeably over the past few years, the EEA said in a publication. It is estimated that almost 60,000 fewer people died prematurely each year from exposure to particulate matter between 2009 and 2018.

Nevertheless, it is estimated that more than 400,000 people die each year due to air pollution from particulate matter, nitrogen dioxide and ground-level ozone.

Emissions fell in the transport and energy supply sectors in particular. In the transport sector, emissions of pollutants such as nitrogen oxide have clearly decreased since 2000 despite increased demand for mobility. In the energy sector, according to the EEA study, the reductions in emissions are considerable.

Deaths from ozone are actually on the rise.

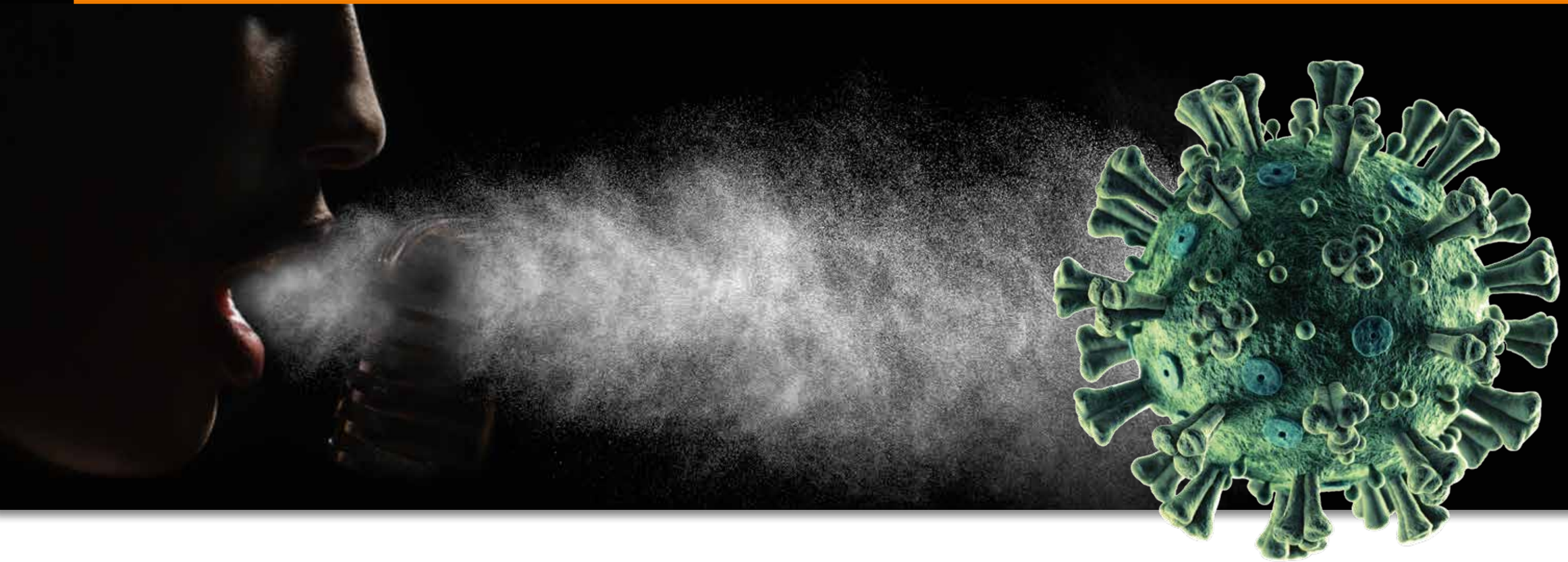
While the death rate for NO_2 across Europe has more than halved compared to 2009, it has increased by a fifth for ozone.

Never before has there been so much CO_2 in the atmosphere.

Due to its high atmospheric concentration, carbon dioxide is the most prevalent gas in the atmosphere after water vapour. The global concentration of carbon dioxide has increased by a good 44% since the beginning of industrialisation and is currently higher than ever before.

In conversation with the respiratory specialist Dr. med. Thomas Hermann Voshaar.

Dr. med. Thomas Hermann Voshaar is a specialist in internal medicine, pneumology, allergology, environmental medicine, physical medicine and sleep medicine. He is also head of the Lungen- und Thoraxzentrum Nordrhein (North Rhine Lung and Thorax Centre) and Chairman of the Board of the Verband Pneumologischer Kliniken (VPK, Association of Pneumology Clinics).



Dr. Voshaar is head of the interdisciplinary lung centre at Bethanien hospital in Moers, Germany. He was one of the first to suspect that the coronavirus spreads mainly via aerosols.

Dr. Voshaar, you said at a very early stage of the coronavirus pandemic that those who tested positive had been infected via aerosols.

Yes. In the early days, it was thought practically throughout the world that the main transmission route was the hands, i.e. it was a smear infection. We knew about aerosol transmission from previous work on influenza. I have been involved in aerosol medicine for about 30 years, albeit primarily in therapeutic applications such as asthma or COPD. Through very close cooperation with aerosol physicists, it quickly became clear that the transmission of the new SARS virus can only be explained via aerosols.

Aerosols are very small droplets or solid particles that, unlike large droplets, remain suspended in the air for longer. Large droplets quickly fall to the ground. It's about the same as when it's foggy and raining. The difference is mainly the droplet size, which determines the physical behaviour. We also carried out tests in replica hospital rooms with mannequins, from which we blew out aerosols to observe how they spread. Another indication that the virus is spread by aerosols is superspreader events in choirs, for example.

Dr. med.
Thomas Hermann Voshaar,
a respiratory specialist.

How can the risk of infection be minimised?

The risk of infection indoors is determined by the number of people, the room size, the length of stay and ventilation, and the air filtration. This explains everything. The recommendations for indoor areas are therefore: wear a mask, only a few people at a time in rooms that are as large as possible, stay for a short time and ventilate. The ratio of the number of people to the size of the room also automatically results in a greater distance between people. Visors and plastic screens do not prevent transmission via aerosols. A smart ventilation system, on the other hand, ensures sufficient air exchange and 'transports' the aerosols out of the room. Effective high-efficiency filters (HEPA 13 and 14) retain the viruses. Room volume and air exchange are the relevant protective factors. A large, high church is less dangerous than a low Methodist hall.

It is practically impossible to become infected outdoors, unless you are standing nose to nose or crowded under an awning, i.e. if there is a limit to the aerosol spread upwards. Otherwise, the aerosol cloud quickly dilutes due to the convection of the air and the practically unlimited space outside. You can observe the phenomenon well with cigarette smoke.

Superspreaders.

Superspreaders are infected people who infect a particularly large number of people. This happens particularly often in situations where many people gather in rooms with a small volume of space.

How long can a virus remain in filters?

Viruses die very quickly in dry environments. Once they are in the filter, they can no longer be released.

What do you think is the danger posed by the opening of schools and childcare centres?

With children up to around the age of twelve, there are still many unanswered questions. Children can be infected in the same way as adults, and the viral load in the throat is comparable to that in adults.

But they only become unwell in extremely rare cases. The most important question has not been conclusively answered: whether children can infect others. So far, all observational studies have indicated that schools are not significant drivers of infection. This is probably because only larger droplets come out of the throat, practically spit droplets, but no aerosol. The older the students, i.e. from secondary school and up, the more we observe the same phenomena as with adults.

These statements are also supported by a study* commissioned by the state of Baden-Württemberg.

In fact, the study shows that children appear to be less likely to fall ill with COVID-19, and also that they are less likely to be infected by the SARS-CoV-2 virus and to infect others.

* The researchers studied around 2,500 children aged 1-10 years and one parent of each, i.e. a total of around 5,000 study participants.

Dr. Voshaar presents the mode of operation of the TROX air purifier to German Federal Health Minister Jens Spahn and North-Rhine Westphalia's Minister President Armin Laschet during their visit to the specialist lung department at Bethanien Hospital.

Can humans develop immunity to the virus?

Absolutely. There is immunity after infection and also after vaccination. Incidentally, the first defence always takes place spontaneously in the throat. This is where humans, quite sensibly, have high immune system activity. But if the throat is bypassed, so to speak, when an infected aerosol is inhaled in high concentrations, infections and serious illnesses obviously occur much more quickly. This is probably because the viruses reach the lungs directly via aerosols in high concentrations.

How does the virus work?

First of all, the SARS virus developed a mechanism to invade human cells as well. It definitely originates from the animal kingdom. It enters the host cell and multiplies there. The virus seems to have developed a particular specialisation for the ACE receptors. In humans, these receptors are mainly found in the lungs, but also in other organs. This then works like a keyhole principle.

We study the virus figures on a daily basis. Words like incidence now pass our lips as second nature. What do you think about the statistics?

The number of infected people alone is not enough information for me. I see a further and better indication in the number of infected people in relation to the number of people who are ill, especially those who are seriously ill.

Moreover, the number of unreported cases must be taken into account, i.e. the number of people tested positive needs to be multiplied by up to 10. Then we have to consider the workload in the health system. Unfortunately, one in five patients die in hospital and one in two after intubation. However, mortality depends very much on age and also on previous illnesses.

What do you think about the recommended quarantine period of two weeks?

People are highly infectious in the first 3-4 days before and after the onset of symptoms. This also shows a very significant problem regarding the spread of infection: the contagiousness even before you notice symptoms yourself.

In our webinar, you mention that not all infected people are the same. What does that mean?

Highly contagious people are those in whom infection of the lungs occurs. Masses of virus-carrying aerosol droplets are released from the infected lungs into the air, where they remain in suspension for a long time and pose a massive risk of infection for everyone in the room. In order to get sick, you have to ingest a certain virus dose, which is probably around 500 viruses for this disease.

What is a virus?

Viruses are infectious organic structures that spread outside of cells by transmission. However, they can only reproduce within a suitable host cell. Viruses are not made up of one or more cells, and they have neither independent replication nor their own metabolism, which is why they cannot be counted as living organisms.

You are not a proponent of mechanical ventilators for critically ill patients – why?

In the hope of being able to favourably influence the course of the infection, patients have been given invasive artificial respiration via a tube in the trachea as early as possible. However, we have increasingly found that artificial respiration seems to do more harm than good. Strategic early intubation, as used across the globe in the early months, was definitely a mistake.

Invasive ventilation is dangerous if used for a long time as it allows pathogens to enter the lungs through the plastic tube. Patients also have to be put into an artificial coma. However, this kind of anaesthesia, especially over many days or even weeks, takes its toll, especially in older people, with many complications.

What happens in the body during severe coronavirus cases?

Basically, severe double pneumonia is the main problem. But the virus also attacks other organs such as the heart, blood vessels, kidneys – and also the nervous system.

As the lungs are practically always the main focus, the daily question is how best to treat these patients with severe oxygen deficiency due to pneumonia. Invasive artificial ventilation must certainly be viewed very critically. This is shown by the poor survival rates with such treatment, in which a machine takes over ventilation via a tube that is intubated. Unlike with natural breathing, air is forced into the lungs at high pressure. So you are turning the normal, natural process of breathing upside down. But there remains a dispute among experts as to what is the right way.

We have had good experience with non-invasive breathing aids. Unlike the invasive procedure, this supports natural breathing and does not replace it. The patient wears a tight-fitting nose and mouth mask through which a device about the size of a shoebox pumps air into their lungs. Currently (as of the end of January 2021), our mortality rate is about 8%; nationally in Germany, it is about 50% after intubation.

Are there any further findings on this?

From the first wave we know the numbers exactly. We analysed the data of 10,000 COVID patients in German hospitals and found that 22% of all patients in hospital died: 53% after intubation, i.e. under artificial, controlled ventilation; in the age group over 80, more than 70% died.

What do you recommend for a healthy approach to life?

Nothing stimulates the immune system better than a positive attitude to life and hearty laughter. Studies show that laughing is good for us.

How does an mRNA vaccine work?

The mRNA vaccine, such as the BioNTech preparation, is based on a completely new mechanism. It contains genetic information about the pathogen, from which the body produces a viral protein – in this case the surface protein with the help of which the virus penetrates cells. The aim of vaccine is to stimulate the body to produce antibodies against this protein in order to intercept the viruses before they enter the cells and multiply.

Dr. Ingmar Hoerr is considered to be the originator of the mRNA vaccination method. In 1999, as a doctoral student at the University of Tübingen, he injected genetic material in the form of DNA into mice. His research subject focused on how to put information into the body that causes the formation of a protein that results in a reaction of the body to produce antigens. In his experiments, he examined the proteins to see whether the programming of antibodies by the messengers substances worked.

Ingmar Hoerr took the messenger molecule RNA, which forms proteins, as a negative control. At the time, RNA was not the focus of research because it is extremely unstable and is immediately degraded again. The surprising moment was when the RNA gave the better immune responses. At that time, virology was mainly working on gene therapy using chromosomal material. However, there is a risk that it integrates into the genes.

'In contrast', says Hoerr, 'we worked with information, not medication. We found that the RNA can distribute information that stimulates the formation of proteins, but then immediately disappears. The RNA effectively provides the cell with the software on how to produce proteins to activate the immune defence. However, as the RNA dissipates quickly, it must be re-vaccinated and the vaccination repeated within a certain period of time, as in the case of flu protection, but this cannot yet be quantified exactly.'

Healthy air in schools.

Coronavirus is a challenge for students and teachers alike. After all, it is precisely in classrooms that virus-contaminated aerosols can spread and remain in indoor air for several hours. For this reason, all schools in Germany are required to ventilate their classrooms regularly.

A classroom in Neukirchen-Vluyn, Germany, where a TROX air purifier minimises the risk of infection.

Advantages of TROX air purifiers.

- Set up and switch on
- Filters 99.95% of all viruses
- Ideal for large rooms
- Large-area air distribution above the occupied zone
- Whisper quiet
- Durable HEPA-13 filter
- Extremely energy-efficient
- HEPA-14 filter combination

Façade-integrated ventilation system in a school.

In practice, this is often not possible. Due to structural and thermal conditions, simply opening windows does only in very few cases provide the necessary exchange of air. Installation of a fresh air system, on the other hand, is associated with structural measures. This makes mobile air purifiers an ideal alternative against virus-laden aerosols in classrooms.

Equipping schools in Neukirchen-Vluyn.

Neukirchen-Vluyn in September 2020. The first ten indoor air purifiers were delivered to schools in Neukirchen-Vluyn, Germany. Mayor Harald Lenßen had already looked at equipment in the summer and was able to convince the city council to purchase it. 'With the air purifiers, we are creating more safety for our pupils and their teachers', Lenßen said at the time.

Another 280 TROX air purifiers were installed in schools in Nuremberg.

TROX air purifiers. The safe stand-alone solution.

The TROX air purifier is the quick and, most importantly, quiet solution for greater safety in schools. The stand-alone unit is simple to set up and switch on. It is so powerful that it can operate at a low level in an average-sized classroom.

As a recirculation unit, it does not replace ventilation, but is a good supplement to extend ventilation intervals so that ventilation from opening the windows, which is particularly uncomfortable in winter, can take place during break times. An upgrade with ventilation systems with fresh air supply would be ideal. However, the German government's €500 million subsidy programme, which runs until 2024, only supports the optimisation of existing facilities.

How it works.

Large quantities of clean air flow from the unit above head height. Aerosols are diluted by the airflow and displaced down to floor level or into the filter. This creates ideal air movement. The two-stage TROX high-performance filter system filters over 99.95% of all airborne viruses – with low noise levels and in an energy-efficient manner.

Aerosols are a major vector for coronaviruses.

With the TROX air purifier, you reduce the risk of transmission in insufficiently ventilated rooms to a minimum – without any complex installations. Simply set it up and switch it on.

Decentralised, façade-integrated air-water systems.

Another very effective option for classroom ventilation is façade-integrated ventilation technology. For this purpose, horizontal or vertical decentralised ventilation units are mounted on the inside of an external wall. However, openings must be created for the outdoor and exhaust air. Highly efficient EC centrifugal fans draw in the outdoor air via the shortest possible route. The air flows into the rooms through a motorised shut-off damper, through fine dust filters ePM$_{10}$ and through the secondary air damper. All components for filtering, heat recovery and thermal treatment are integral parts of the ventilation unit.

The units create an inducing displacement flow with very few draughts. The fresh air is pre-heated in winter and pre-cooled in summer. EC fans and an integral heat recovery unit prevent the warm room air from being exhausted unused, thereby increasing the efficiency of the entire system.

SCHOOLAIR ventilation units.

Decentralised façade and ceiling ventilation units type SCHOOLAIR are specially designed for use in schools. They provide a significantly higher volume flow rate than the previous models. Two units are sufficient to provide standard classrooms with the required fresh air in order to ensure an average CO_2 concentration of less than 1,000 ppm in rated ventilation mode. Boost mode, with an output of up to 600 m³/h per unit, is usually set shortly before, during and shortly after break times and ensures rapid air exchange between lessons.

PISA also confirms the importance of mechanical ventilation.

In Europe, it is primarily the Finns, and more recently also the Estonians, who – taking all three areas together – head the table of Europe's educational elite. TROX life has analysed the results and is on the trail of the secret to the Northern European countries' educational success. Dutch scientists have only recently discovered, as part of a field study, that concentrations of CO_2 in the classroom have a measurable effect on schoolchildren's ability to learn. As part of the study, pupils who were taught in buildings with room air conditioning systems had noticeably better grades.

In light of this finding, ventilation experts are no longer surprised that the Finns are well in the lead when it comes to success in education. This is because – unlike us in Germany – they discovered the effect of good room air quality on education for themselves a long time ago, as a result of which mechanical ventilation for schools has been enshrined into building regulations in the far north. The CO_2 content is not permitted to exceed 1,500 ppm for an extended period of time. And the Danes are following suit. A building regulation that came into force on 1 January 2011 specifies a maximum CO_2 level of 1,000 ppm for schools.

Statement

Udo Jung, member of the Board of Management of TROX GmbH, on the current situation:

'In the air conditioning and ventilation industry, we are currently facing major challenges. On the one hand, the focus here is on the fundamental trends in technical building services, such as digitisation, energy efficiency, heat recovery and, last but not least, the topic of sustainability. On the other hand, the industry is developing reliable ventilation options from its core competence to reduce the risk of infection in closed rooms. We are currently very surprised that many experts from outside the field are playing advisory roles here, even in the federal government, instead of turning to appointed expert circles, such as from science or from our associations FGK, VDMA, RLT and VDI. It is about nothing less than the preservation of our social and economic life as well as our educational life. Therefore, it can only be right that we also see this as an opportunity, take up distancing, hygiene, mask and ventilation rules in a competent manner and collaborate, for example, on opening options for schools, local authorities, offices, cinemas, etc. Various publications from the scientific community and associations show how this can work.'

TROX Auranor wins the award for the most courageous company of the year!

In November 2020 TROX Auranor was awarded 'Næringsmot 2020' (which means business courage), making it an exceptional example of entrepreneurial courage.

In a tough and demanding selection process, the Norwegians impressed in all three criteria:

- TROX Auranor is well rooted in the local community and also a national and international player.
- TROX Auranor is an excellent employer, currently with 170 permanent employees.
- TROX Auranor contributes to a positive and courageous corporate culture through continuous investment in its own operations and development.

The new, completely climate-neutral facility in Hadeland.

Left to right: Managing Director Peter Sønderskov, Head of Production Tormod Grindstad and Executive Secretary Torunn Lismoen.

The latest investment in a new, completely climate-neutral production facility particularly impressed the jury. The winner also impressed as it has chosen to invest in a new plant in Hadeland at a time when it is common to move industrial production to low-cost countries.

But this new project is also special in other respects. Sustainability is the top priority here – and that includes construction, of course. And in order to produce in a CO_2-neutral way from day one, TROX Auranor has invested 300 million Norwegian kroner in innovative digitisation tools, in 100% renewable energy, in highly efficient tools, equipment and systems, and even in charging stations for the electric vehicle fleet.

This courage to implement responsibility for more climate protection so effectively is definitely deserving of a prize.

TROX on the road.

Can't come to us?
Then we'll come to you!

TROX even has the right solution for cancelled trade fairs and limited opportunities to connect. The TROX Roadshow, which has been on tour throughout Germany since the end of 2020, demonstrates efficient and intelligent ideas for protection against virus-laden aerosols indoors directly at customer sites.

The state-of-the-art trailer is equipped with the new TROX air purifier and a SCHOOLAIR ventilation unit, and directly demonstrates the effectiveness of the two filter systems – with low noise levels and in an energy-efficient manner. Detailed information materials and an interesting video about the spread of aerosols in rooms with the corresponding solution approaches from TROX also provide important background knowledge. Our specially trained advisers from our branches will also competently answer any questions on the subject of the coronavirus and ventilation. And of course, as part of a safe, rule-compliant hygiene concept, there will also be filtered, virus-free air inside the trailer.

The TROX Roadshow got started in December in Kassel, followed by Gießen, Fulda, Koblenz, Düsseldorf, Dortmund, Münster, Cologne and more. We plan to get out on the road again in the near future, by which time this should also be possible in other European countries. Ultimately, however, the development of the coronavirus pandemic will decide where and when the TROX Roadshow can be continued so that we can keep our customers informed in the usual detail, even in these unprecedented times.

Achoo!

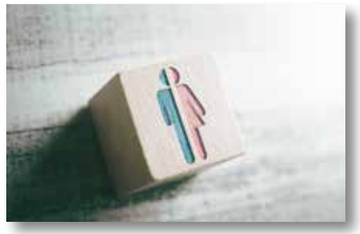
Achoo! In the not-so-distant past, in Germany you would say ‘Gesundheit’ when someone sneezed to wish for good health. But then, according to Knigge’s German rules of etiquette, this was no longer the done thing. The new guideline was that the person who sneezes should actually apologise and the others should simply nod in a friendly manner.

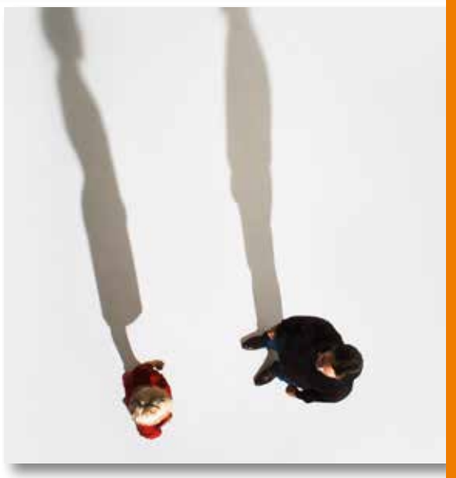
The reason the Knigge Society saw for this was the fact that the wish for ‘health’ still came from times when the plague was rampant in Germany. If someone sneezed, people said ‘Gesundheit’ to wish health not to the sneezer, but to themselves. But isn’t it a bit over the top to suddenly overthrow habits that have been part of our lives for years? The German guardians of good manners have now taken it back and now we may – with a few exceptions – wish for good health again.

A healthy dose of common sense.

Likewise, the ongoing discussions relating to gendered language in Germany are breaking previously valid rules of conduct. But in my opinion, this has little to do with common sense. Now we have to use both male and female titles and start all our party conferences with ‘Liebe Genossinnen und Genossen’ (‘Dear members’) and all our memos with ‘Liebe Mitarbeiterinnen und Mitarbeiter’ (‘Dear colleagues’). For me, this is a waste of time. Printed out, it also produces even more paper. What’s wrong with addressing our fellow citizens as ‘Mitbürger’ (without the additional feminine -innen ending) whether they are male or female?

This focus on the gender-correct form of address was a stumbling block for German politician Annegret Kramp-Karrenbauer at her party conference when she greeted her fellow party members with the correctly gendered address, but called them ‘Social Democrats’, despite being the leader of the Christian Democratic Union.





In Baden-Württemberg’s Minister President Winfried Kretschmann, I see a prominent comrade-in-arms. ‘I don’t think much of all this hyperbolic language’, Kretschmann said, adding that everyone should ‘be able to speak as ‘he’ sees fit, without searching for the ‘right’ words’.

Spring is here, and just like the blossom appearing, the ‘prescribed’ use of language seems to be becoming more and more abundant. Words like fireman, mankind and chairman are suddenly taboo. But in all honesty, why shouldn’t we just call things as we see them?

I wish all our readers much health, wealth and happiness. Here are some wise words on the subject of health:

‘I have chosen to be happy because it is good for my health.’

Voltaire

‘Health is not everything, but without health, everything is nothing.’

Arthur Schopenhauer

‘The best doctors in the world are Doctor Diet, Doctor Quiet, and Doctor Merryman.’

Jonathan Swift

‘Be careful about reading health books. You may die of a misprint.’

Mark Twain

‘The path to health leads through the kitchen, not through the pharmacy.’

Sebastian Kneipp

TROX® TECHNIK
The art of handling air

Published by:
TROX GmbH
Heinrich-Trox-Platz
47504 Neukirchen-Vluyn, Germany
Phone: +49 (0) 2845 2020
Fax: +49 (0) 2845 202265
trox-de@troxgroup.com
www.troxtechnik.com

Production:
TR advertising GmbH
Arnulfstraße 33
40545 Düsseldorf, Germany

Editors:
Christine Roßkothen, TROX GmbH
Klaus-Arndt Hueter, TROX GmbH
Klaus Müller, Kommunikation & Marketing

Associate editors:
Thorsten Dittrich
Ralf Joneleit
Udo Jung

Printed by:
MD-Digital GmbH
Niederrheinallee 320
47506 Neukirchen-Vluyn, Germany

Art director:
Alexandra Höver

Photo editors:
Alexandra Höver
Klaus Müller

Image sources:
Cover/back page: iStockphoto
P. 4/5: TROX GmbH
P. 6/7: TROX GmbH, Markus Kümmerle, SKK
P. 8–11: TROX GmbH
P. 12/13: TROX GmbH, iStockphoto
P. 14/15: TROX GmbH
P. 16–21: iStockphoto
P. 22/23: TROX GmbH, Adobe Stock
P. 24–29: iStockphoto
P. 30/31: TROX GmbH, iStockphoto
P. 32/33: Prof. Dr.-Ing. Martin Kriegel, TU Berlin, iStockphoto
P. 34/35: Adobe Stock, Felix Noak, HRI / TU Berlin, iStockphoto
P. 36/37: TROX GmbH, Felix Noak, HRI / TU Berlin, iStockphoto
P. 38/39: imago stock&people, iStockphoto
P. 40–43: iStockphoto
P. 44/45: Stiftung Krankenhaus Bethanien, Moers
P. 46–49: iStockphoto, Stiftung Krankenhaus Bethanien, Moers
P. 50/51: Adobe Stock, iStockphoto
P. 52/53: TROX GmbH, iStockphoto, dpa Picture-Alliance
P. 54–59: TROX GmbH
P. 60/61: Adobe Stock
P. 62/63: iStockphoto

Published in April 2021

FSC
www.fsc.org
MIX
Paper from responsible sources
FSC® C030157

TROX GmbH
Heinrich-Trox-Platz
47504 Neukirchen-Vluyn
Germany
Phone: +49 (0) 2845 2020
Fax: +49 (0) 2845 202265
trox-de@troxgroup.com
www.troxtechnik.com