Technologies

X-CYCLONE®, REVEN® and REVEX® Technologies

X-CYCLONE® technology protected by international PCT patent rights, based on further improvement of the arrow geometry!

X-CYCLONE® technology was developed for the separation of air-borne substances, such as aerosols, fluid and spraying mists and fine dusts that are released during manufacturing and finishing processes in the food processing and manufacturing industry.

Thanks to decades of continuous research and development, we succeeded in presenting the fifth product generation of the X-CYCLONE® air cleaner to the world in 2012.

The new air cleaner is characterised by a new arrow geometry and an increase in separating efficiency of 20 %.

REVEN®
X-CYCLONE
Air Cleaner
Luftreiniger

X-CYCLONE® - the Heart Piece of the REVEN® Product Line

Made entirely of stainless steel

Stainless steel frame fitted with aluminium profile sections

The X-CYCLONE® system is available in two versions:

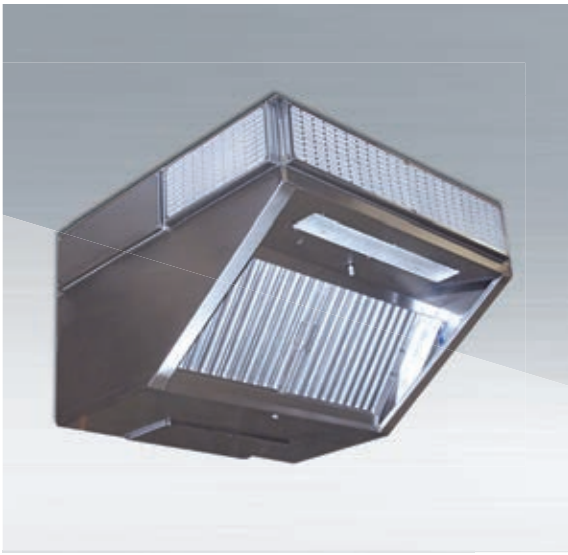
- Made entirely of stainless steel for food industry
- With a frame of rustproof stainless steel fitted with profile sections of seawater-resistant aluminium alloy for processing industry

In practice, the X-CYCLONE® system consists of rectangular elements with a thickness of 50 mm. The correct designation is X-CYCLONE® basic aerosol separator element.

REVEN® Grants a Life-long Guarantee on the X-CYCLONE® Basic Elements.

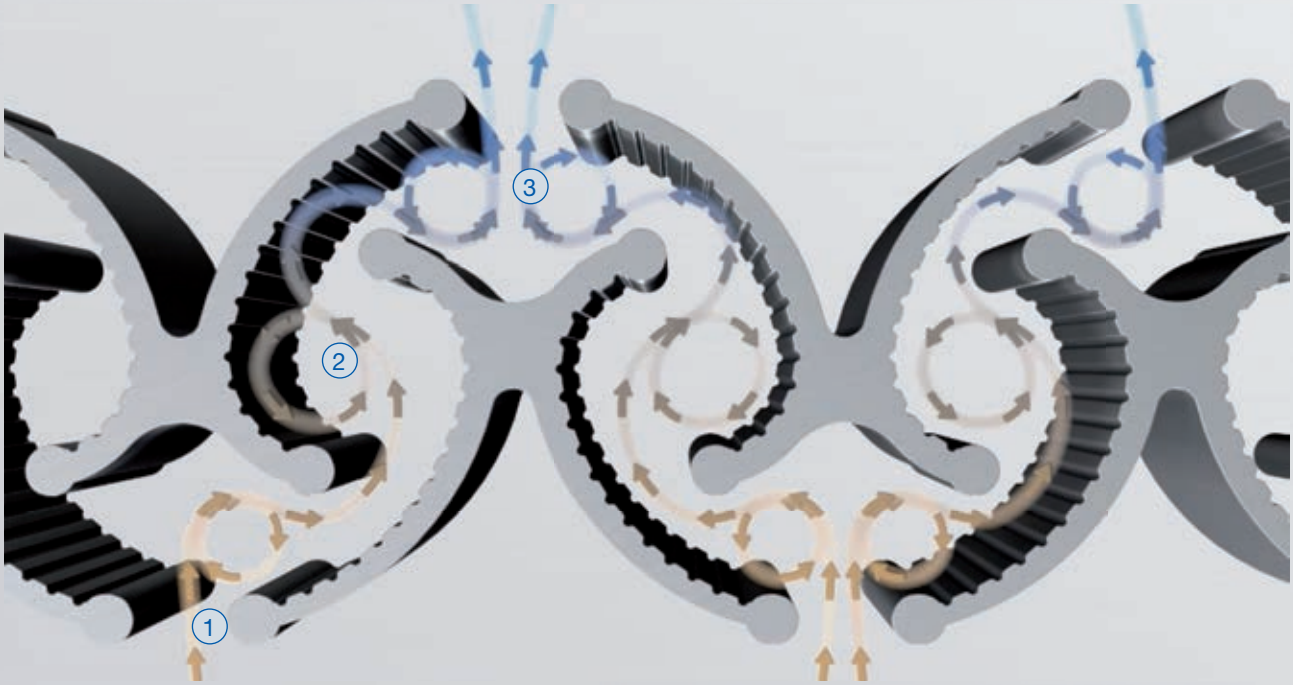
The X-CYCLONE® basic element is self-cleaning and needs no maintenance! The aerosols separated in the basic element run down as fluid mass along the X-CYCLONE® profile sections. As it runs off, the liquid washes away solids that accumulate on the profile surfaces of the basic element.

Disposable products that must be replaced at regular intervals are not required. Operation and maintenance are therefore far more cost efficient than with conventional air cleaners.



Functional Description of the Separation in the X-CYCLONE®

Separation in the X-CYCLONE® basic aerosol separator element takes place in four stages:



STAGE 1

The extracted air polluted by aerosols flows into the X-CYCLONE® basic element. When entering the element (1), the airflow is accelerated considerably. The acceleration produces a first separation.

STAGE 2

The highly accelerated airflow starts swirling (2) inside the profile sections. The rotational vortex flow ejects airborne aerosols.

STAGE 3

The rotational vortex flows collide with non-rotational airflows at the air outlet (3) of the X-CYCLONE® basic aerosol separator element, thus resulting in an agglomeration and further separation of smaller aerosol particles.

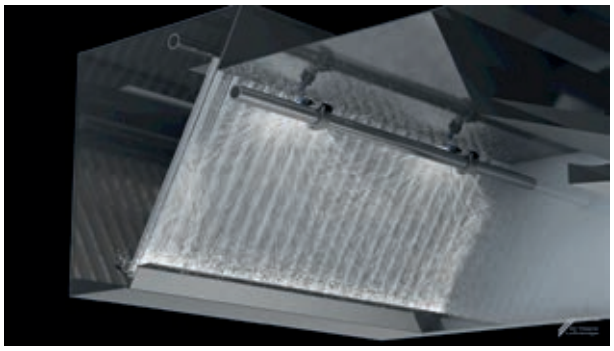
STAGE 4

The aerosols separated in the X-CYCLONE® basic aerosol separator element accumulate on the profile surfaces and run down as fluid mass (4) to the bottom of the element.

Fine dust is separated in the same way.
The dust particles do not run down like the fluids (4), however.

A REVEX® system must therefore be integrated if dry and sticky fine dusts are separated. The REVEX® system is based on a patented spraying technology that fulfils two functions:

A) It cleans the profile surfaces of the X-CYCLONE® basic aerosol separator element automatically and

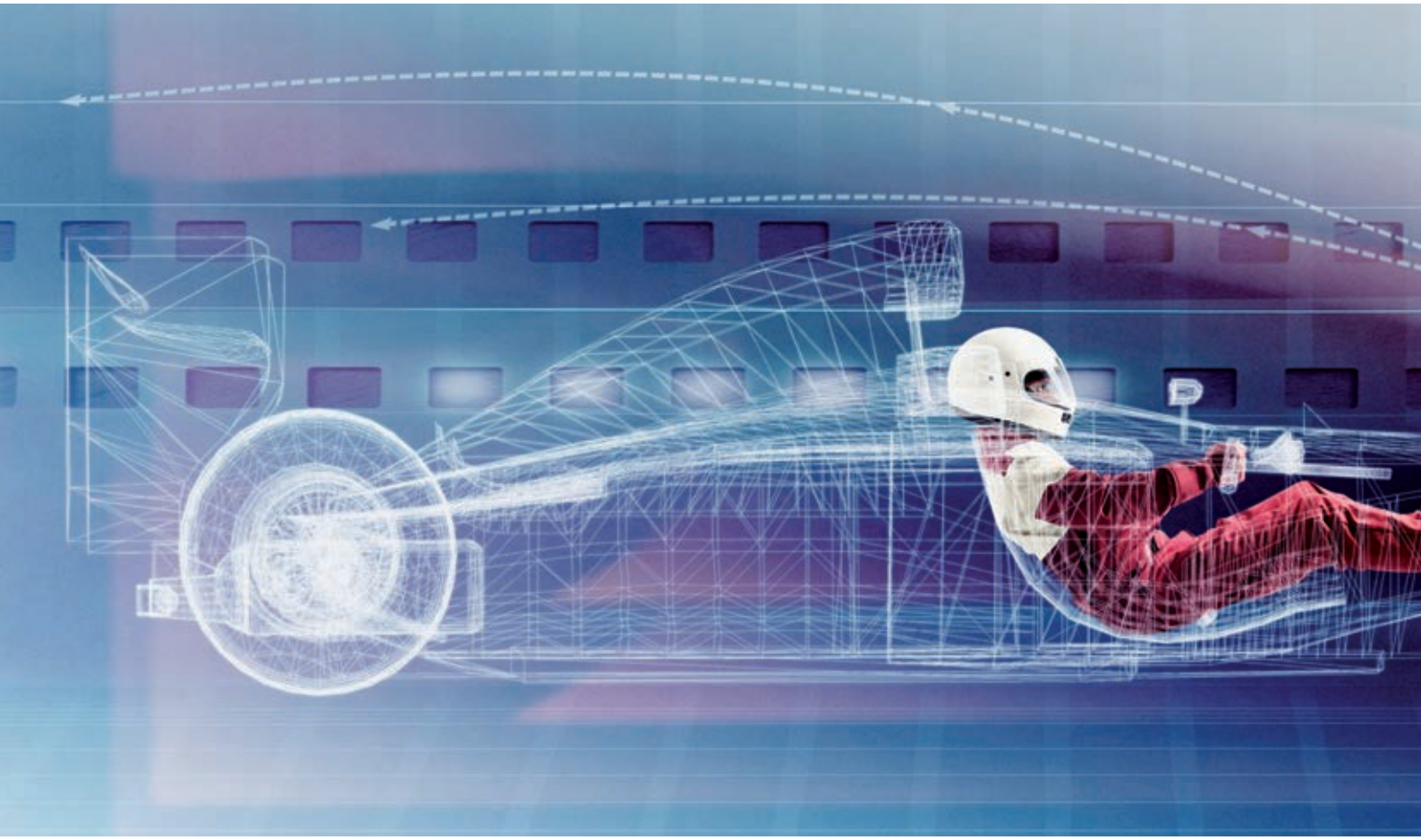


B) cleans the air in the same way as an air washer in chemical industry. The continuous air washing by the REVEX® spraying system washes even the smallest aerosols and harmful gases out of the airflow.

The illustration shows a compact X-CYCLONE® air cleaner of the CR series with an integrated REVEX® spraying system ensuring automatic cleaning and continuous air washing.

CFD Simulation

For years, the X-CYCLONE® and REVEN® systems have been continuously analysed and progressively improved with the help of CFD!

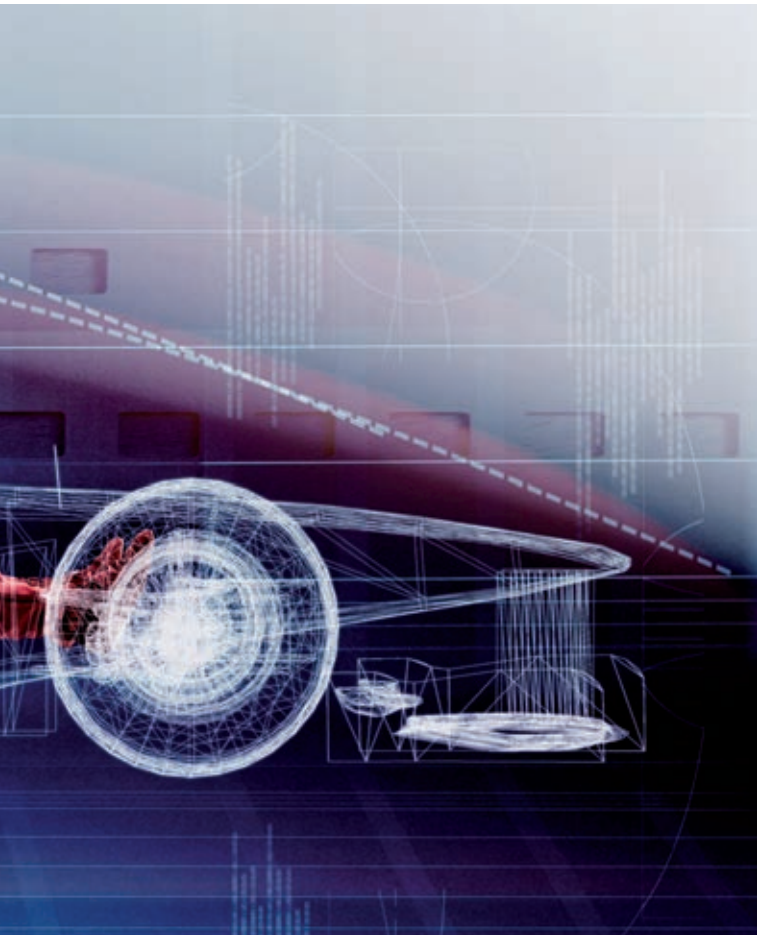


Airflows are complex and cannot be mapped by analytical means. The only way to examine and understand these flows and gain useful knowledge for the improvement of processes and products is their simulation with computational fluid dynamics (CFD).

Even highly complex airflows at the front and back spoilers of modern Formula One racing cars are analysed and optimised by today's racing teams with the help of CFD simulation.

The airflows outside and inside the chassis of a Formula One racing car, an air cleaner or an induction collection hood are decisive for perfect and efficient functioning.

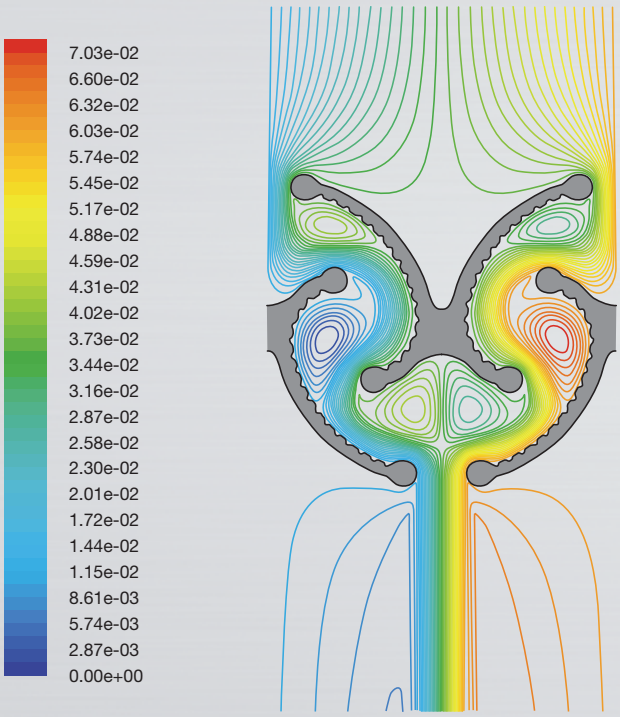
CFD simulation maps these important invisible processes in their entire complexity with sound physical and mathematical models. The great benefit in comparison to experimental methods and measurements lies in the fact that CFD maps all physical entities together in their interaction and provides



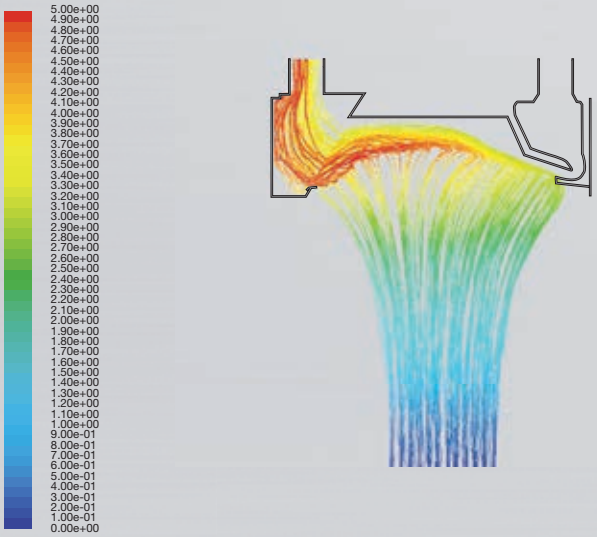
evidence of the functioning instead of delivering values merely for selected points.

This is the reason why we have used CFD simulation for years to analyse and improve our equipment.

The X-CYCLONE® air-cleaning system and REVEN® induction system were both developed with the help of CFD simulation!



Contours of Stream Function (kg/s)



Particle Traces Colored by Particle Residence Time (s)

Workplace Exposure Limits

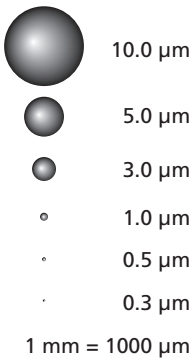
Clean air for workers in industry

In food processing as well as machining processes on machine tools, high concentrations of PM10 aerosols are released.

PM10 aerosols are airborne particles with a diameter of less than 10 µm.

The comparison with a human hair illustrates the difference in size between a five-micrometer particle and a human hair.

PM10 particles may occur in very high concentrations in certain processes. An air volume of a thousand cubic metres might contain PM10 concentrations of up to 500 grams.



The WELs for air pollution in the processing industry differ considerably from country to country. The same applies to the verification and control of compliance with these limits. Many studies have revealed in the meantime that even outdoor air pollution in cities has a decisive influence on the health and mortality rate of exposed people. For this reason, REVEN® bases the design and dimensioning of its equipment on the far more stringent outdoor exposure limits adopted in the metropolises of the world. In many large cities, the maximum permitted concentration of fine dust is 50 micrograms per cubic metre of air. REVEN® is committed to the following quality goal: the air quality demanded for people in large cities and the limit values that apply there must also be achieved for the industrial workers.

The illustration shows the city centre of Brussels. The air in industrial factories must comply with the same standards of purity!

You should also take note of the interview with our CEO Sven Rentschler published in Germany's leading mechanical engineering magazine "maschine + werkzeug", edition 10/2011, page 72.

REVEN® technology for healthy air at workplaces

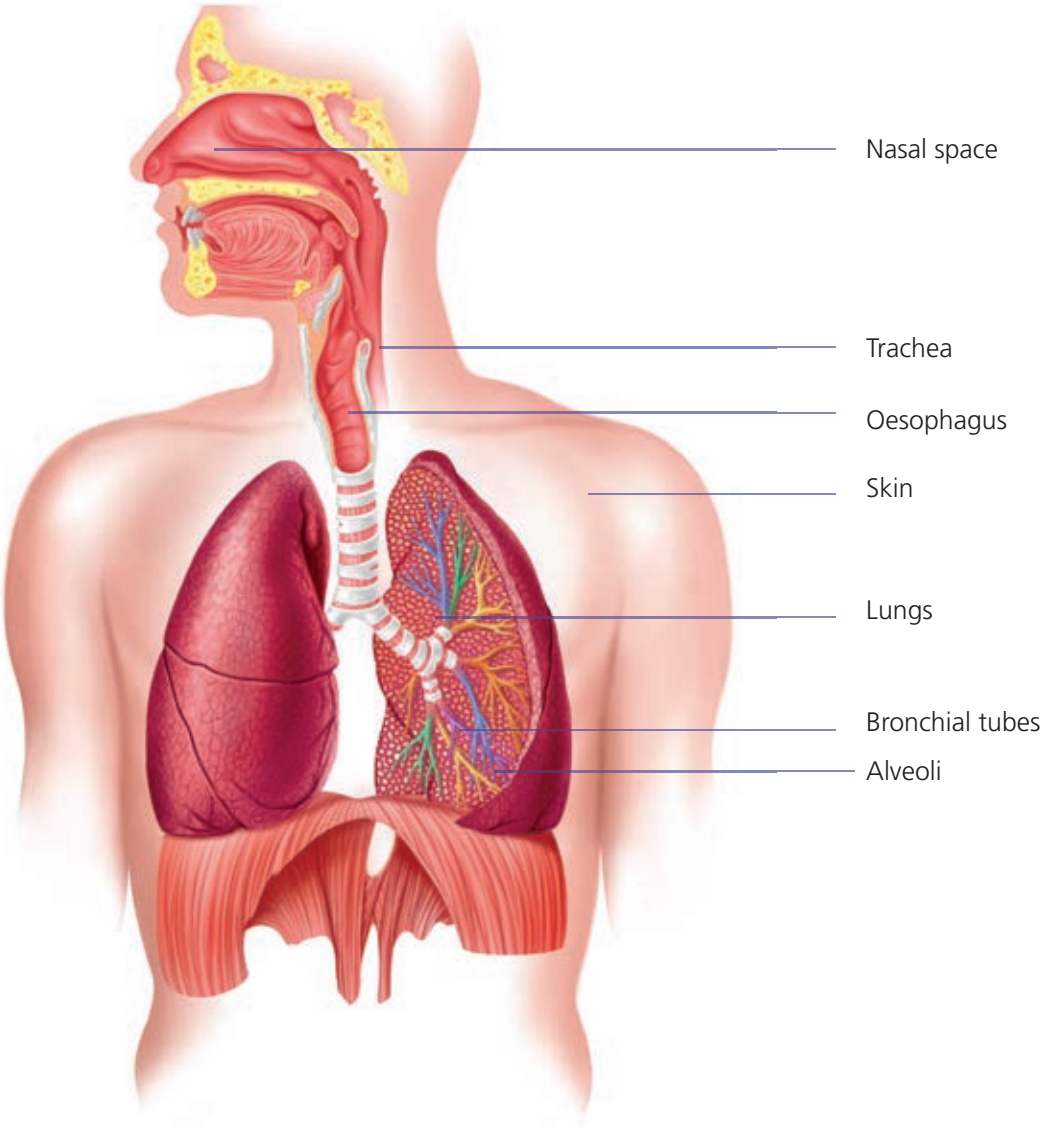
X-CYCLONE® in Compliance with Protective Regulations

Protection of personnel and machines

BREATHING
gases, vapours, dusts, aerosols

SWALLOWING
dusts and fluids

SKIN RESORPTION
dusts and fluids



Scientific research proved that fine dust and airborne aerosols with a droplet diameter of less than 5.0 µm constitute an increased health hazard to exposed personnel. When breathed in, the particles enter the lungs and can cause severe respiratory ailments such as asthma or pulmonary fibrosis. Fine particles are also risk factors for various cancer types. The fine particles do not only enter the body via the respiratory tract, they can also be ingested via the oesophagus or absorbed by the skin.

Possible harm to sensitive plant and machinery, buildings and the environment should not be forgotten either.

Interview with Sven Rentschler

Excerpt on the topic of WELs

What are the limits of pollutant concentrations in air treated with air cleaners?

The fine dust pollution in the outside air has been a matter of discussion for several years now. Vehicle and industry emissions are the focus of attention. The term 'fine dust' refers to the mass of all particles with a diameter of less than 10 micrometres included in the total dust quantity. According to the findings of the World Health Organisation, respiratory and cardiovascular ailments increase with exposure to high concentrations of these fine particles. In order to ensure health protection, exposure limits for outside air concentrations have been introduced by the authorities. Since 2005, a limiting value for daily exposure of 50 micrograms per cubic metre of air has

been adopted throughout Europe. In the wake of this regulation, the badge system for urban traffic was one of the measures introduced in Germany.

And which exposure limits apply at the workplace?

The permissible air pollution WEL is 10 milligrams per cubic metre for cooling lubricant vapours and aerosols with a flash point above 100 degrees Celsius that are emitted during metal processing. The same exposure limit applies to processing machines with a minimum lubrication system. This WEL is two hundred times higher than the limit for outdoor air pollution!

Is fine dust always the same?

Fine dust in city traffic pollution is certainly not the same as that generated on processing machines. The latter is not fine dust in the traditional sense. It consists of cooling lubricant particles that are emitted during machining processes. However, those cooling lubricant vapours and aerosols are very similar to fine dust with regard to the particle sizes and the health hazards involved. With a diameter of less than 10 micrometres, these cooling lubricant particles enter the vascular system via the lungs. They are therefore considered particularly harmful. Even though several studies have proven that a fine dust load of 50 micrograms in the outdoor air measurably reduces the life expectancy of exposed people, we still allow processing machine operators to be exposed to indoor levels that are 200 times higher. I can hardly understand that. These regulations are not consistent.

Is there only a health risk in the immediate proximity of the machine?

No. In metal processing workshops, the indoor air is extracted frequently, cleaned and returned to the workshop. In our experience, many of these extraction systems achieve a filtering performance of only two milligrams of cooling lubricant vapours and aerosols per cubic metre of cleaned air. The concentration of pollutants imposed on the operators is still 40 times higher than the permissible limit concentration for outdoor air. Professional associations should take the matter in hand without delay and update and harmonise the WEL regulations to a reasonable level.

You also conduct measurements in companies. What are your findings there?

The total bandwidth of air pollution can be found, from the proper manufacturing company with clinically clean workplace air to factories where the WEL of 10 milligrams is exceeded by far. The processing machines may have the CE label applied to them, but they can still be put into operation without an efficient filter because many manufacturers offer the filters as an optional extra. I cannot understand that.

Are there positive examples too?

Yes, of course. Groups of companies increasingly adopt their own standards and apply them to their sites all over the world. Volkswagen, for instance, maintains a very high level of air purity in their factories. I also know that GM and Ford have internal guidelines that go far beyond government regulations.

Interview in Germany's leading mechanical engineering magazine "maschine + werkzeug", edition 08/2011, page 72

Test Stand for Flame Exposure Testing

Flame exposure testing in accordance with DIN 18869-5, DIN EN 16282-6 and UL 1046

In connection with manufacturing and finishing processes in mechanical engineering and the food industry, high concentrations of highly inflammable aerosols often have to be extracted and separated.

If the aerosols ignite in the exhaust air duct, the flames can spread into the whole building via the duct and set entire building complexes on fire within a few minutes.

In order to prevent rapid flame propagation, the flame-arresting capability of all our X-CYCLONE® basic aerosol separator elements is tested in accordance with national and international standards.

REVEN® Oil Mist Separators Successfully Pass Explosion Tests

This is why all our X-CYCLONE® basic elements comply with all German, European and North American requirements with regard to their flame-arresting capability.
Even their behaviour in explosive environments has been tested and documented.