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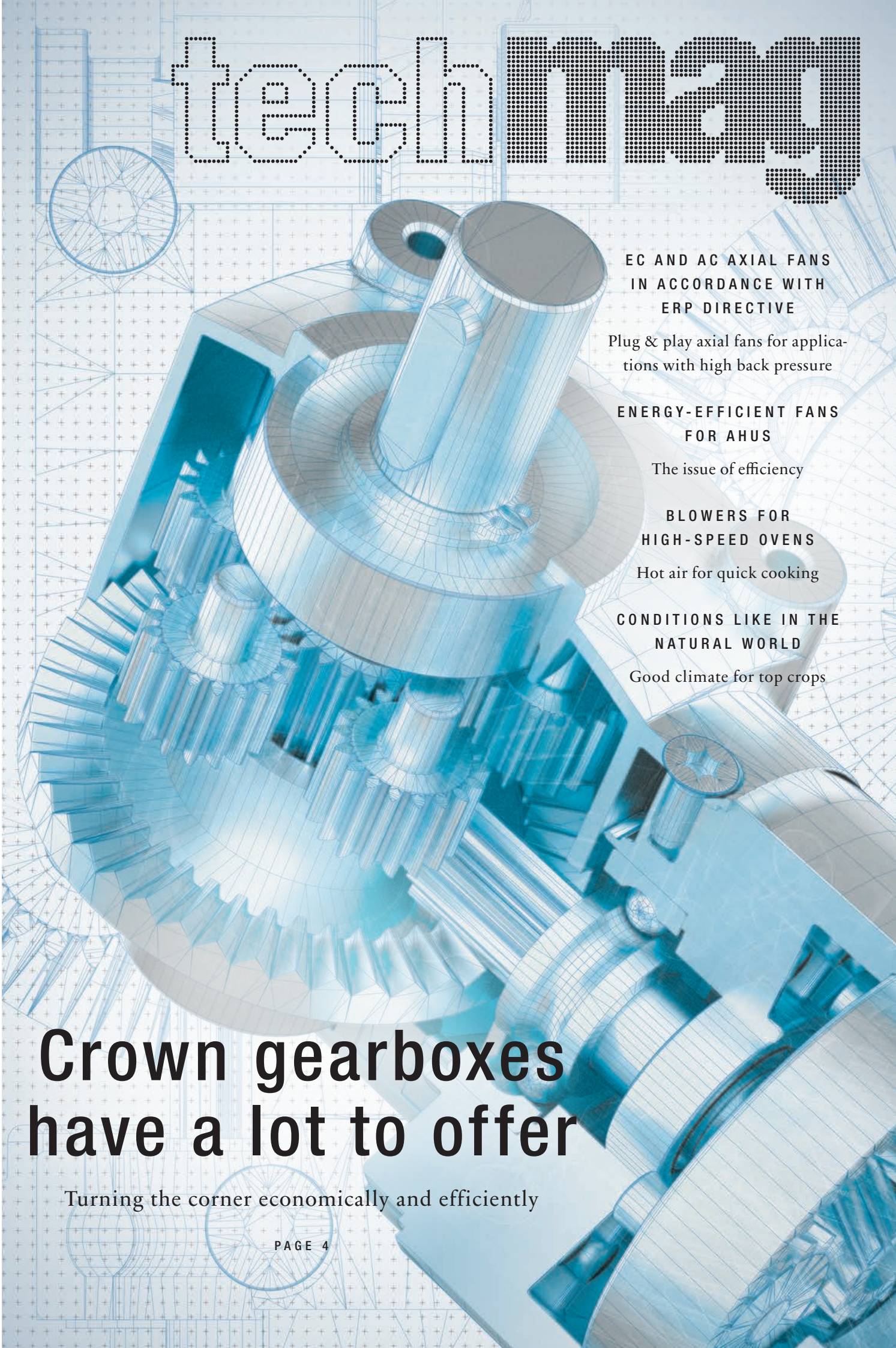

EC AND AC AXIAL FANS IN ACCORDANCE WITH ERP DIRECTIVE

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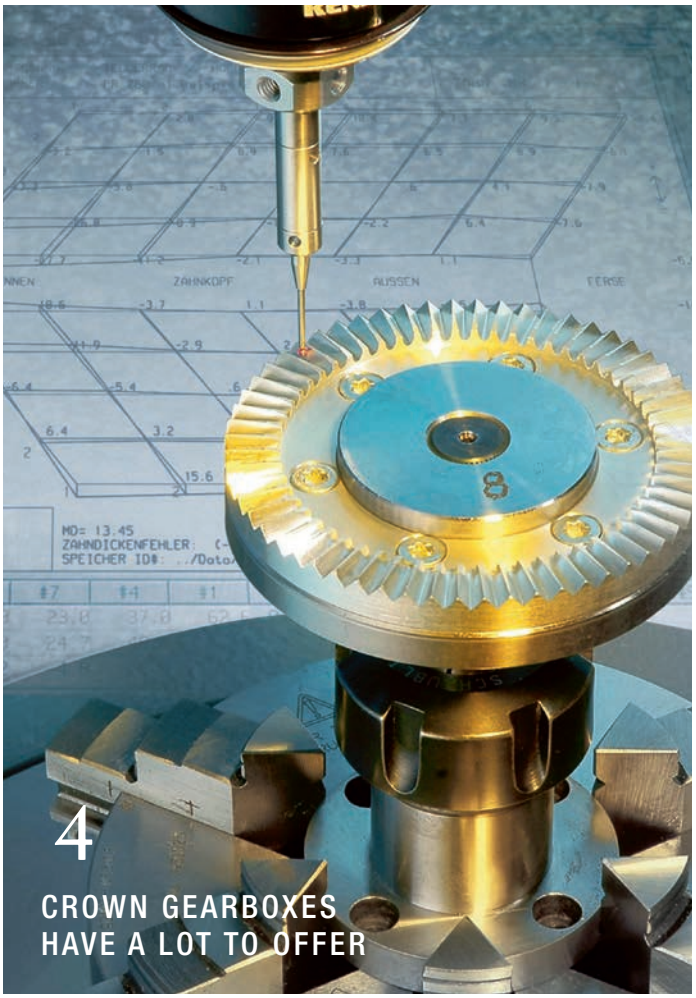


“Compact drives are more in demand than ever before”

Johannes Moosmann

DIRECTOR BUSINESS UNIT
INDUSTRIAL DRIVE
EBM-PAPST ST. GEORGEN

Dear Customers, Partners and Friends of ebm-papst,

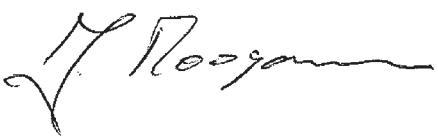
In drive technology, there is a trend towards decentralization. This is what we are seeing at many manufacturing companies. The Industrial Internet of Things is a major topic here. In future, production processes will no longer be driven centrally, but rather where the work is actually being performed. However, this requires the appropriate drive systems on site and in tight spaces, which is why compact drives are more in demand than ever before.

And they also have to achieve a lot. This is a technical challenge that we overcome with our EtaCrown and EtaCrownPlus crown gearheads, because they offer greater efficiency than other crown gearheads.

Our crown gearheads also translate the applied torque within very small dimensions and, at the same time, they "steer" the power of the motor around the corner. This is particularly ideal if there is very little space available. This means that the drive system can, for example, move rotary doors in entry systems without attracting a lot of attention or it can be used in driverless transport systems with a battery-driven power supply.

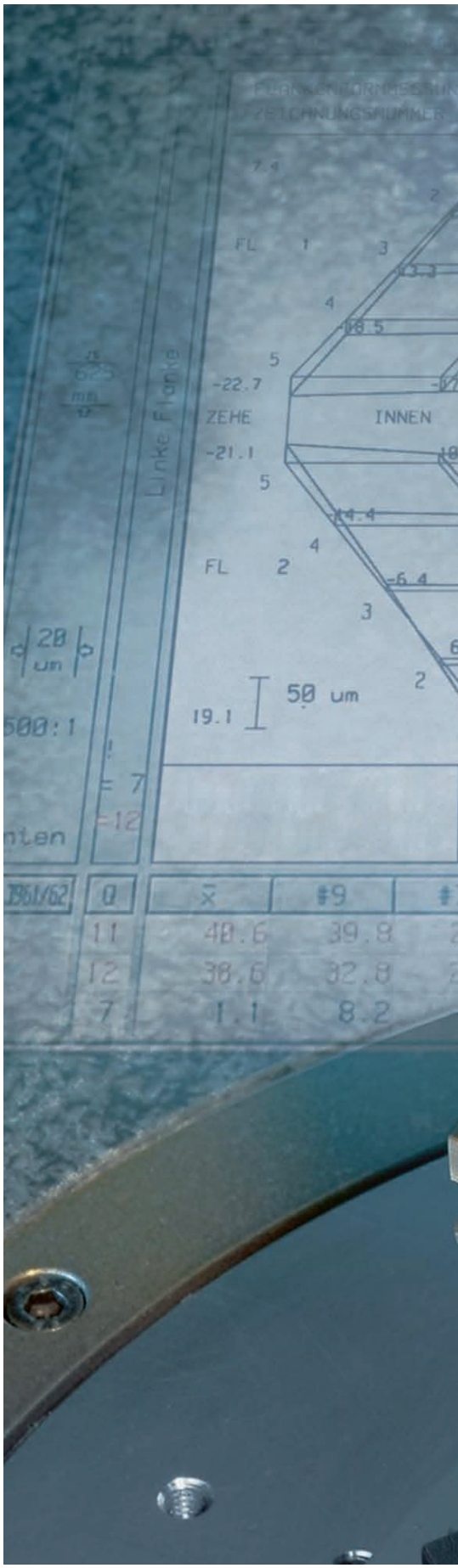
However, in addition to the size requirements, this type of transport system also requires efficiency and reliability. Our drive systems not only have to be compact and powerful, they also have to be robust and energy-efficient. We have been offering you optimum solutions for decades, especially when it comes to energy efficiency. And we are well equipped for the future when it comes to this too. After all, our cleverly designed drive components achieve very high efficiency levels in a networked system. Therefore, almost all of the energy supplied goes towards the intended purpose. Losses caused by mechanical friction and the electrical energy supply are minimal, which also prevents disruptive heat generation. And even if energy losses occur due to external influences or the drive is blocked externally, our drive systems are intelligent enough to identify, communicate and respond quickly to the changed conditions. This is a basic requirement for the Industrial Internet of Things and makes our intelligent drive systems fit for many innovative customer requirements.

I hope you enjoy reading the latest issue of tech.mag!

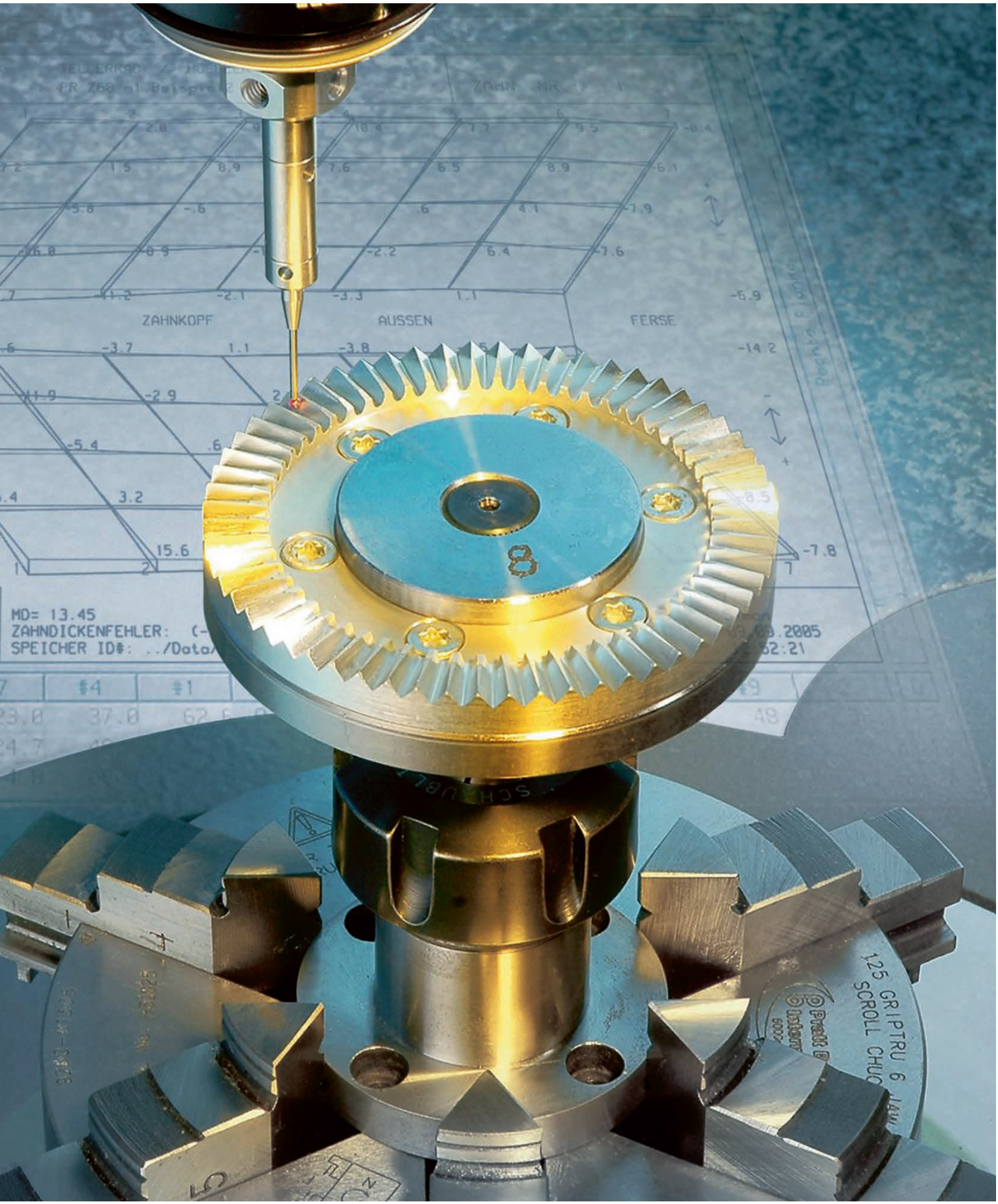


Turning the corner economically and efficiently

Crown gearboxes have a lot to offer



If drive power is supposed to “turn the corner,” bevel or worm gears are widely used to reduce the speed of high-speed electric motors. However, there are always disadvantages when these are used. Due to their principle, worm gears have an axle offset between the drive and output shaft and work at comparatively poor efficiency levels, so that drives often have to be dimensioned larger. Bevel gears are usually limited to a reduction ratio of max. 5:1 and are therefore also not the ideal choice. Although their efficiency is very high, their manufacturing process is complex, which is of course reflected in the price. So anyone looking for an especially economical and efficient crown gear-boxe should focus on crown gear technology.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Crown gearboxes were already used in technical systems a century ago and can still be seen today in historic mills. Over the course of time, they were displaced by bevel gears because these were easier to calculate; the crown gear disappeared from the market. However, this changed when the focus shifted to energy-efficient drive technology in industry and to smaller drives. After all, the right combination of efficient motors, gearboxes and control systems enables high energy savings in the power range below 250 W. As decentralized drive technology has become more important in machine and plant engineering due to its flexibility, there is an increasing number of such drives. Transmissions that operate at the highest possible efficiency are therefore in demand, and this is where crown gearbox technology can score points. The gearbox specialist Zeitlauf, which is now part of ebm-papst, recognized this early on and re-defined traditional crown gearhead technology with EtaCrown and EtaCrownPlus (Fig. 1). State-of-the-art crown gearboxes of various sizes cover the reductions in the single-stage range

The efficiency is also in the range of 90% at high reductions.

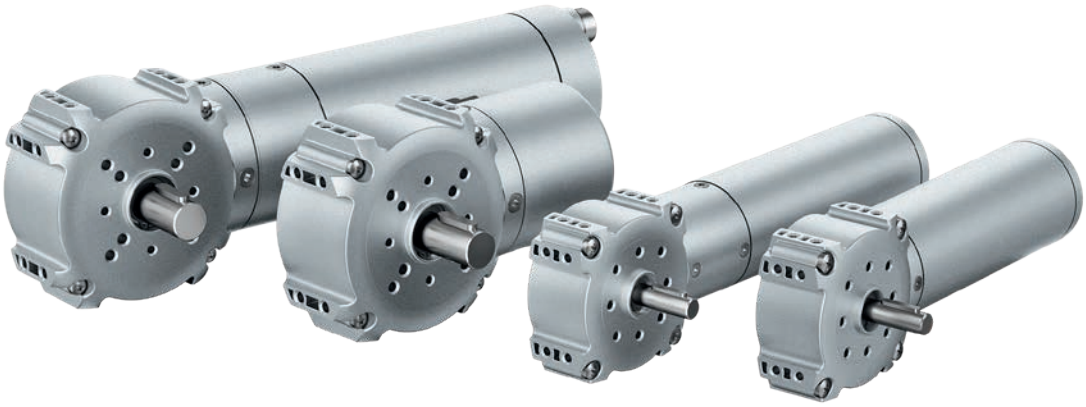

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FIGURE 1: **The EtaCrown crown gearboxes (here as a motor-transmission combination) cover the reduction range from single-stage to 10:1, two-stage to 113:1 and three-stage to 289:1 in various sizes, achieving efficiency levels of more than 90%.**

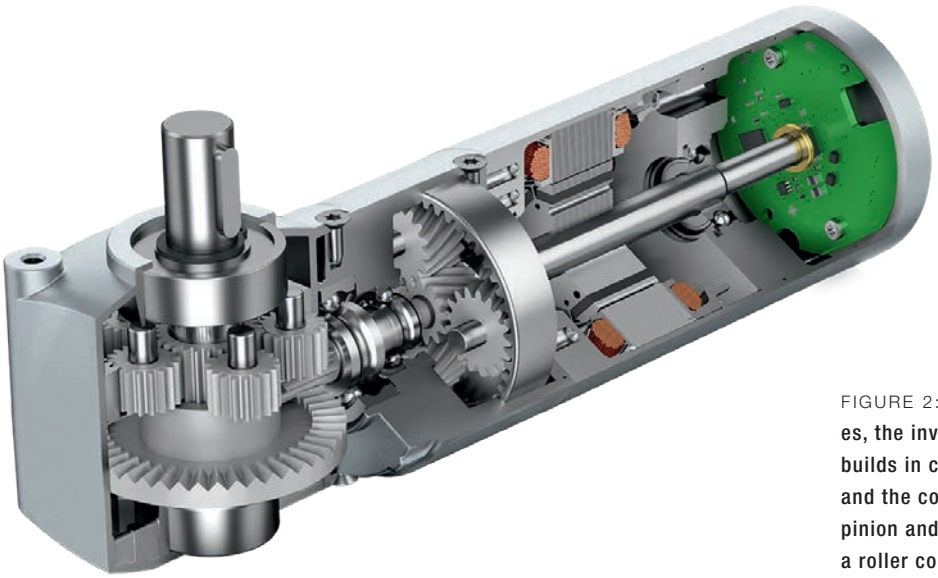

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FIGURE 2: **In crown gearboxes, the involute drive pinion builds in cylindrical form and the contact between the pinion and the output gear is a roller contact; hardly any friction losses occur.**

up to 10:1, two-stage to 113:1 and three-stage to 289:1. In the single-stage range, they achieve efficiency levels of more than 90% and can be manufactured more economically than bevel gears. Due to their principle, crown gearboxes also place fewer demands on the center distance adjustment than bevel gears and even achieve a reduction ratio of 10:1 from a single stage (bevel gear: 1:5).

Great efficiency with high reduction

If you take a closer look at the design of the various crown gearboxes, you will understand quickly why crown gearboxes are a good choice for many applications: Gears of bevel gears have a conical shape. The gear function is only perfect if the center lines of the bevel gears cut at exactly one point. As a result, even thermal expansion can impair the function. Worm gears are less sensitive, but with them the direction of the force flow is very unfavorable. The torque results primarily in a tensile or pressure load on the worm pinion. Since the pinion slides on the worm gear, depending on the reduction, up to 2/3 of the input drive energy is converted into heat. The motor and the transmission must therefore be dimensioned larger than actually necessary to achieve the desired power. In addition, the axial load on the worm gear has to be absorbed by the correspondingly dimensioned axial bearings.

With the modern EtaCrown and EtaCrownPlus crown gearboxes from the ebm-papst modular drive system, this is different (Fig. 2): The involute drive pinion builds in cylindrical form and the contact between the pinion and the output gear is a roller contact; hardly any friction losses occur. The efficiency is therefore also in the range of 90% at high reductions. The motor power is thus almost fully available for the drive task. 10% power loss compared to up to 75% for conventional worm gear designs is an enormous potential for savings even in small drives. It is often also pos-

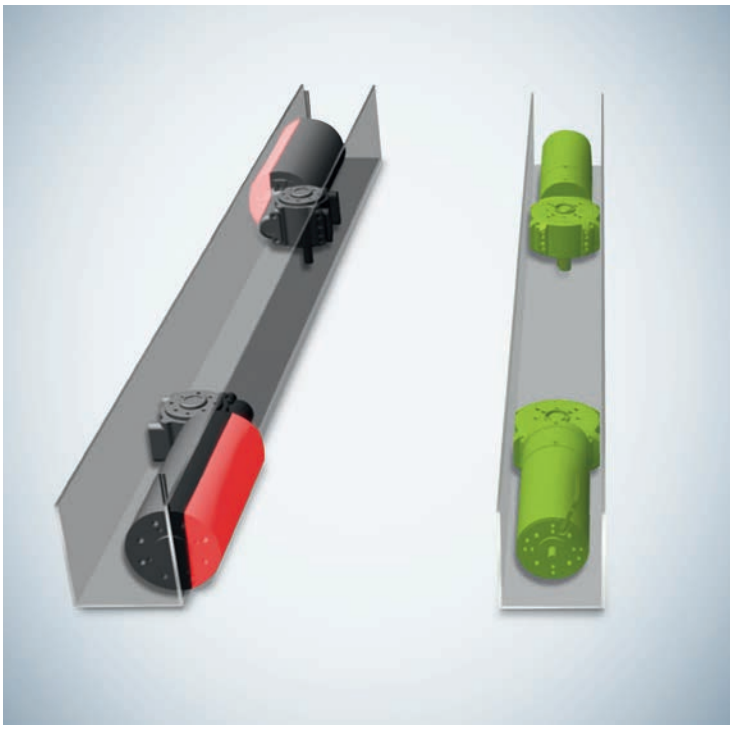

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FIGURE 3: **The motor-crown gearbox combination can be integrated into the profiles due to the offset-free design. There are no motor protrusions, which prevents recesses or additional spacers for bypassing intervals.**

Crown gearboxes impress with their great reliability, smooth operation and low heating.

sible to dimension the drive motor smaller and save space and costs. As the motor with drive pinion and the output axle are in one plane on the EtaCrown, the transmission can also be installed easily mirrored, which reduces storage and simplifies logistics.

Advantages in the application

There are many applications for which crown gearboxes are recommended and in which they have proven effective for many years. In addition to the high efficiency levels, typical reasons for using them are the high transmittable torque and the lack of self-locking. In the case of barriers and access monitoring systems, for example, the transmissions can be turned back manually even in the event of a high reduction without the need for components for decoupling to protect the drive against damage. Due to the offset-free design, the motor-transmission combination can also be integrated easily into door profiles (Fig. 3). There are no motor protrusions. This avoids recesses or additional spacers for bypassing distances. The symmetry in the gear design makes versions for left or right stops unnecessary. The brake can be mounted directly on the drive shaft or, as usual, on the B side of the motor, simplifying the design and making the drive system more compact.

Other applications for the versatile crown gearboxes include lift trucks and automated guided vehicles (Fig. 4). High transmittable torques, durability and compact dimensions speak for the use of a crown gearbox. In medical technology, crown gearboxes impress with their great reli-

ability, smooth operation and low heating. EtaCrown and EtaCrownPlus are part of the ebm-papst modular system and can be combined with all DC and EC motors as well as brakes and encoders. Customized complete drive solutions from a single source with perfectly matched components can be combined easily in the online portal; thanks to defined preferred types, selected drive configurations are ready for shipment within 48 hours. which means that sampling, for example, can be done very quickly. ○

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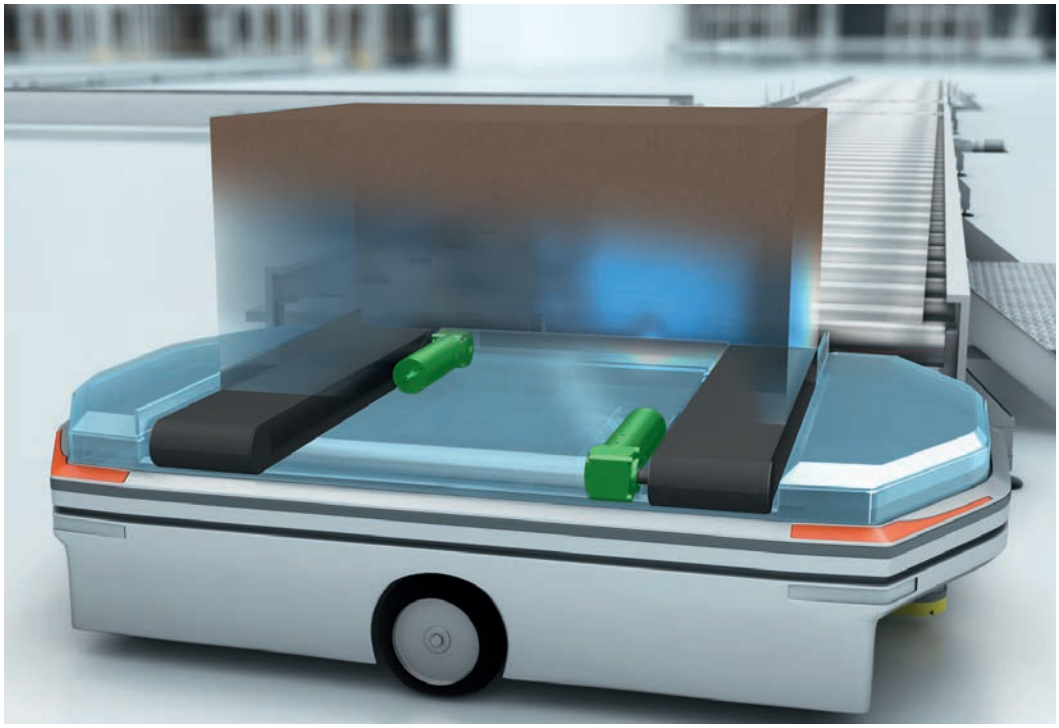

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FIGURE 4:
Crown gearboxes are suitable for use in guided vehicle systems: The efficient transmission ensures safe and flexible movement.

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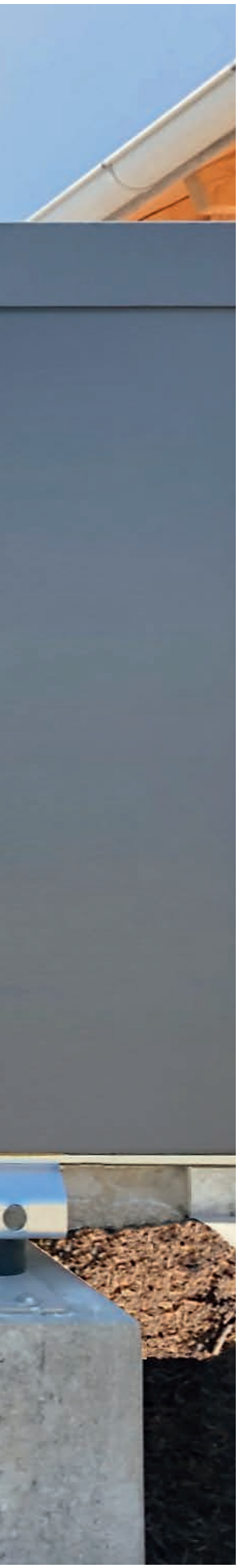

EC and AC axial fans in accordance with ErP Directive
(EU Eco Design Directive 2009/125/EC)

Plug & play axial fans for applications with high back pressure

Axial fans are normally used for situations when strong air flow with relatively low back pressure is required. That is why they have not yet been the fan of choice for ventilation and air conditioning devices that have components that require a high pressure increase. But now that has all changed: ebm-papst's new axial fans are also suitable for applications with high back pressure, meaning that these types of applications can also benefit from their higher air flow rates. The ready-to-install plug & play solutions are extremely energy-efficient, and both the EC and AC versions fulfill the next stage of the ErP Directive.

At the start of 2020, ebm-papst introduced its AxiEco Protect axial fans with guard grills, which are able to overcome high back pressure. The fan and motor specialist is now going a step further by expanding its existing AxiEco series with the AxiEco Perform (Fig. 1) axial fans. These achieve even greater efficiency and pressure stability and come with an easy-to-install housing made of composite material. The air performance curve is much steeper than that of comparable axial fans, and efficiency remains high, even when back pressure rises (Fig. 2). As a compact plug & play solution with CE marking, the fans are easy to integrate into applications. Users won't have to worry about nozzles or distance to the impeller, nor concern themselves with conducting their own ErP assessment.

Thanks to the addition of the new fans, the AxiEco series now covers a very broad range of applications. For example, the AxiEco Protect fan with guard grill is particularly well-suited for noise-sensitive applications, as its noise emissions are very low. By contrast, the AxiEco Perform fan with housing is recommended when a ready-to-install fan is needed. With air flows of up to 12,000 m^3/h and pressures of up to nearly 500 Pa, they are ideal for a broad spectrum of applications, ranging from heat pumps and evaporators to industrial ventilation systems and the cooling of air compressors. The new fans with housing come in sizes 300, 350, 400, 450, and 500 and are available in EC and AC design. Both the EC and AC variants of this series also meet the requirements of the future ErP Directive and can be used for both exhaust and suction.

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FIGURE 1: **Extract from the product range: new AxiEco Perform EC axial fan in size 350 with housing made of composite material.**

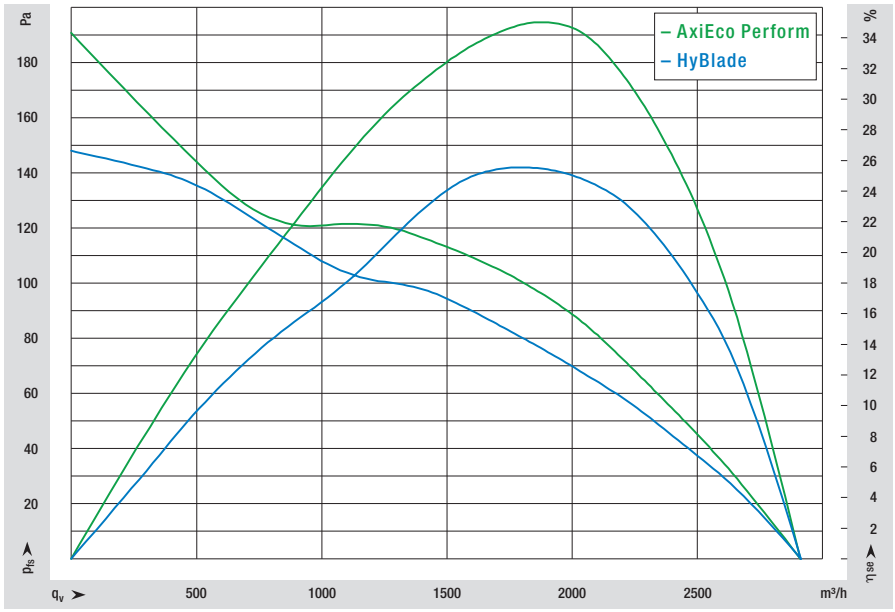
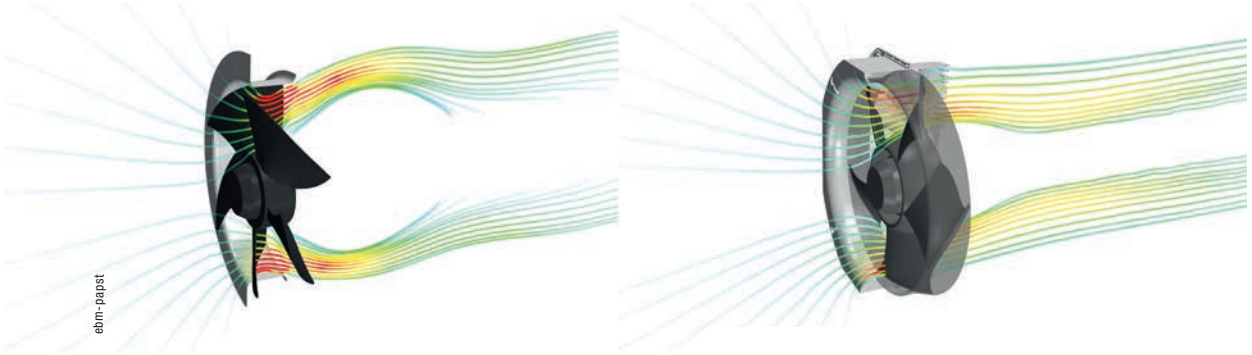


FIGURE 2: **The air performance curve of the AxiEco Perform is much steeper than that of the HyBlade, and it offers all that at a high efficiency.**

Aerodynamic design increases efficiency and air throw

Optimized aerodynamics lie at the heart of the fan's design and are what help to increase efficiency and pressure: the impeller, integrated diffusor ring and hub form a compact unit and the blade tips pass over straight into the integrated diffusor ring. This eliminates the head gap between the nozzle and the impeller, which also prevents air from flowing over the tips of the blades, as seen in conventional axial fans. The new design both increases efficiency and reduces noise. The integrated diffusor ring also functions as a diffuser that is directly integrated into the impeller. It increases the pressure, resulting in reduced exit loss and less noise. Thanks to the inlet ring that immerses in the impeller and a larger outlet opening, the fan has an optimal flow (Fig. 3).

The fan also features an aerodynamically optimized housing with integrated guard grill and guide blades. Cavities in the housing corners improve the flow; the guide blades ensure that the swirl in the outflow field of the fan, and thus the dynamic losses, are reduced



HyBlade AxiEco Perform

FIGURE 3: **Thanks to the inlet ring that immerses in the impeller, the large outlet opening, and the housing design, the AxiEco Perform fan has an optimum flow.**

to a minimum. The air throw is also higher compared to conventional axial fans (Fig. 4). This means that in large refrigerated warehouses for example, there is an even distribution of cold air, so fewer fans may suffice.

Application-compatible design details

In terms of exhaust-based applications, an optional guard grill can be attached to the intake side of the housing. If the fans are used for evaporators, an air bag that closes the air outlet opening during defrosting and when the fan is switched off can be easily installed. It is fixed to the cylinder-shaped housing using the standard tensioning belt. The air bag keeps the trapped heat in the evaporator housing during the defrosting process. This significantly reduces the defrosting time and makes for a low final defrosting temperature, thus saving a considerable amount of energy.

The flow profile at the outlet of the AxiEco Perform fan ensures that the integrated guard grill does not freeze over as quickly, as there is backflow – even at high back pressures. And the impeller with the integrated diffusor ring has been produced in highly resistant composite material, a material that, in and of itself, discourages icing. The grooves on the rear of the fan blades provide the necessary mechanical strength for achieving the high impeller speeds for the impressively high pressures. They also ensure that any water present can easily drain away in applications in which the fan has been installed with a vertical motor shaft.

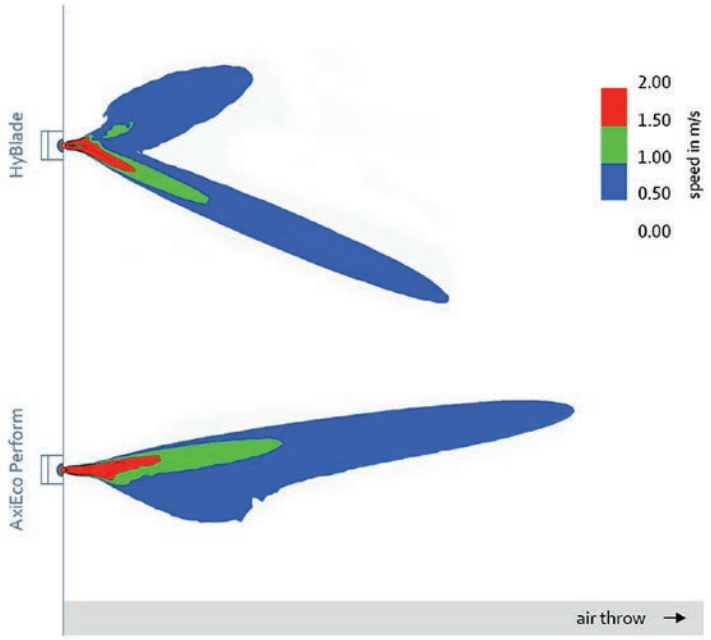


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FIGURE 4: **The air throw from the AxiEco Perform is considerably better than from the HyBlade.**

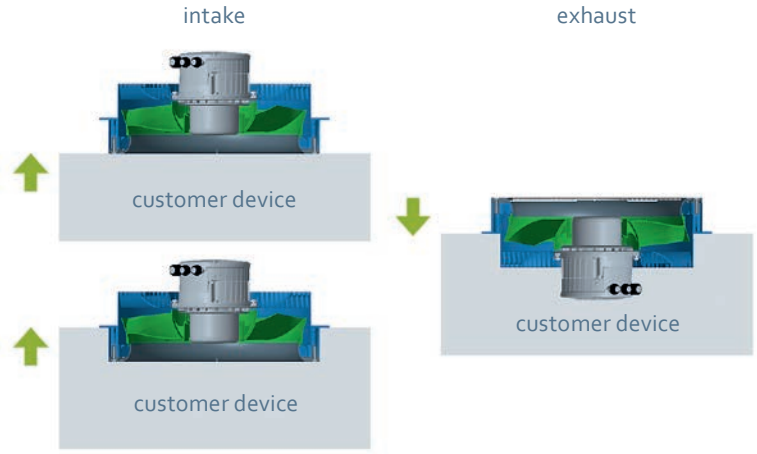

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FIGURE 5: **Different installation methods for intake and exhaust operation.**

As a compact plug & play solution with CE marking, the fans are easy to integrate into applications.

Different installation options and needs-based control

The sophistication of the housing design makes the fan easier to install and enables a number of potential installation methods (Fig. 5). For example, for intake operation, the fans can be installed "on top", i.e. on top of the customer's device, or "semi-top" (recessed into the device). For exhaust operation, the entire fan unit is installed in the customer's device the other way around using the central flange and fitted with the intake-side guard grill. When used in ventilation pipes, the central flange makes it easier to install the fan directly on the pipe system. This makes it easy to integrate the fans into ventilation applications.

The new AxiEco Perform fans satisfy the requirements of the next ErP stage, regardless of the motor technology they have. And the fans with EC motors offer many more advantages. In comparison to AC motors, EC motors function with considerably higher efficiency. They also generate less waste heat, an important advantage for chilling applications. It is also possible to control and monitor the fans on a needs basis using a 0-10 V signal or MODBUS. These features help the EC fans to work very efficiently, particularly in the partial-load range, and significantly reduce energy consumption. This facilitates individual adaptation to particular cooling requirements. Typical examples include the maturing of cheese and the ripening of sensitive fruit and vegetables in storage, and varying day and night operation. The new features enable needs-based air flow to be easily set in ventilation applications as well. The high speeds of the EC motors also provide much higher air performance, which are hugely welcomed for many industrial applications (Fig. 6). ○

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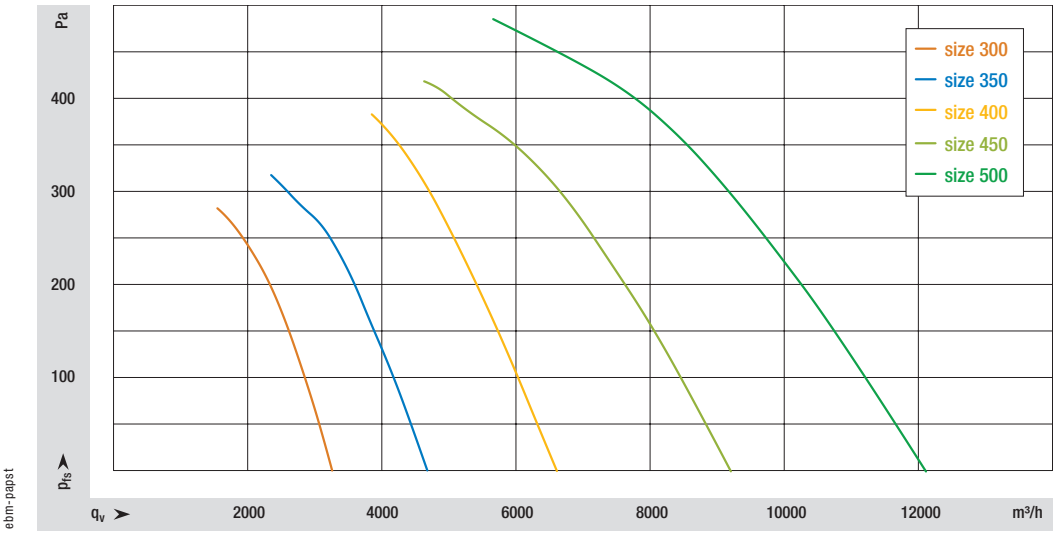

FIGURE 6: **The fans come in sizes 300, 350, 400, 450, and 500 and are available in EC and AC design. With air flows of up to 12,000 m³/h and pressures of up to nearly 500 Pa, they are ideal for many different applications in refrigeration, air conditioning, ventilation technology and mechanical engineering.**

Energy-efficient fans for AHUs

The issue of efficiency

By definition, energy efficiency describes the relationship between energy output and energy input. Of course, this also applies to fans. However, deciding which fan is the most efficient, and works at the maximum energy efficiency, is not that simple: Fans are complex flow machines that react to every change, including installation conditions, speed variations or pressure ratio changes due to filter contamination. As a result, no fan works at the "best efficiency" at all times and in all places. Having said that, centrifugal fans are the better choice for most applications in AHUs.

Every fan's air performance, noise and efficiency depend on the geometry of the impeller, the housing components, the speed and the diameter. Theoretically, both centrifugal and axial fans can be used in air handling units (AHUs). In both designs, the air is drawn parallel to the axis of rotation. While the outflow for axial fans is primarily parallel to the axis, the air in centrifugal fans mainly escapes outwards and radially from the center, i.e. centrifugally. In both designs, the air flow is also directly proportional to the speed, while the pressure increase rises with the square of the speed. Which is the better choice depends on the application involved. The installation and operating conditions are important factors for the fan to work at optimum efficiency and with minimal noise emissions.

Axial fans: a sensible solution?

Axial fans work most efficiently when they convey air – for example via a heat exchanger – into the open at low back pressures. To achieve the best possible efficiency, an axial fan's impeller should be positioned in a fan housing that has been aerodynamically optimized. Together with a front plate, this ensures the correct flow control and provides the separation required between the intake and outlet sides. The characteristic curve of a typical axial fan is marked in blue (Fig. 1, p. 18). Therefore, axial fans achieve optimum efficiency at high air flows and do so with minimal noise emissions. Axial fans are sensitive to inflow fluctuations without additional measures, such as an upstream guide vane. It is also often useful to have a discharge vane on the outlet side to

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optimize efficiency, which means more mechanical effort during the assembly and an increased overall length. The outflow characteristics of axial fans are very focused compared to centrifugal fans, which is a disadvantage when applying air to downstream filters or heat exchangers. However, if the outflow goes directly into a duct network, this can be advantageous (Fig. 2).

Centrifugal fans: the better choice

Centrifugal impellers are intrinsically less sensitive to influences on the inflow and outflow sides. The development of RadiPac centrifugal fans from ebm-papst, specially designed for installation in AHUs, not only involved optimizing the energy efficiency and noise emissions of the impeller, motor, control electronics and housing: it also involved considering the actual installation conditions in AHUs. The result is clear: this choice of fan does not require large reserves to be prepared for installation losses. Furthermore, centrifugal fans without a scroll housing are particularly flexible when it comes to outflow variants out of the AHU. Since the fans apply air to a pressure chamber (pressure plenum), it is possible to connect to a duct network in virtually all directions without significant losses.

What is the definition of efficiency?

Theoretically, efficiency is defined using the quotient of output over input. In ventilation technology, the parameters are air conveying performance (air flow x pressure increase) divided by electrical power consumption. However, this information alone does not guarantee that the manufacturer's specifications will be comparable. First of all, it is important to determine which components the fan concerned contains. If there is only a fan impeller, the efficiency values cannot be compared to the values of a complete fan consisting of control electronics (VSD), a motor and a fan impeller. Simply multiplying the individual efficiency levels of the various fan components at their optimum point is not enough either. Although this is often done in practice, you cannot expect all the components used to work at their optimum efficiency when they are put together, especially considering that component manufacturers often only provide optimum efficiency values. It is difficult to obtain values for partial load behavior at a reduced speed. To obtain realistic information about efficiency levels, the entire fan unit has to be measured as a whole.

$$\eta_{\text{Fan}} \neq \eta_{\text{max Motor}} * \eta_{\text{max Impeller}} * \eta_{\text{max Control electronics}}$$

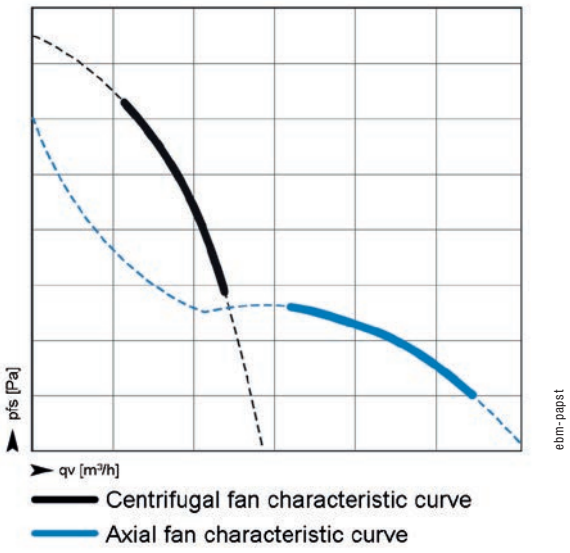

FIGURE 1: **Differences in the characteristic curves of centrifugal and axial fans.**

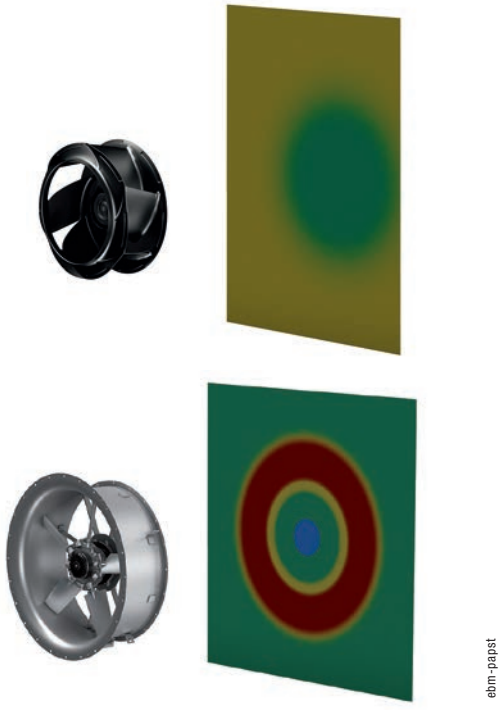

FIGURE 2: **Axial and centrifugal fans can be used in air handling units (AHUs). Centrifugal fans (left figure) ensure that the air is applied more evenly to downstream fittings (filters, heat exchangers) than with axial fans (right figure). The axial speed is presented in color.**

Back to the definition of efficiency. Air performance is defined by multiplying the air volume and the pressure increase. The air flow, i.e. the air volume, is provided by the air conveying task. The pressure increase required is found by determining the components that the air flow passes through, such as filters, heat exchangers and the connected air path. As a sum, this is the overall pressure. It is specified as static pressure and is used to select the fan.

Nowadays, the terms total pressure and total pressure increase are also common. The total pressure is the sum of the static pressure and the dynamic pressure and, therefore, is always higher than the static pressure alone. Therefore, this information should be treated carefully when comparing the efficiency of fan systems. Because:

$$q_V * p_{stat} < q_V * (p_{stat} + p_{dyn})$$

Therefore also

$$\eta_{stat} < \eta_{tot}$$

Therefore, different fan systems have to be made comparable before you can realistically compare their energy values. First of all, as described above, this involves how the fans are composed and the definition of the pressures used in the calculation. Instead of talking about percentages of efficiency, it is better to compare fans for a defined air conveying task using the expected power consumption. It is also important to evaluate how the fan will react with its surroundings when installed. These variables, called installation losses (system effects), can become rather important for different fan types and installation conditions, and must be added to the required (static) overall pressure increase when selecting the fan.

Here, axial fans perform much worse with a very high partial speed level than centrifugal fans without a scroll housing. Measurements by ebm-papst have shown that even the best axial fans on the market do not achieve the overall efficiency levels or the low noise levels of centrifugal fans (Fig. 3). However, the efficiency and acoustics of axial fans can be significantly improved using combinations of sound absorbers, diffusers or guide blades mounted on the outlet side. Yet, even with these measures, which significantly increase the overall length, you are best off with a common centrifugal fan.

Centrifugal fans with modern EC technology

The power consumption values specified in technical documents are important when selecting fans. You also need to correctly interpret the specified efficiency levels. With axial fans, you also need to consider the fact that the aerodynamically instable operating range (stall area) is very close to the fan's optimum efficiency. If the system curve changes to higher pressures, this can have a devastating effect on the device's operating safety and, therefore, on the entire system.

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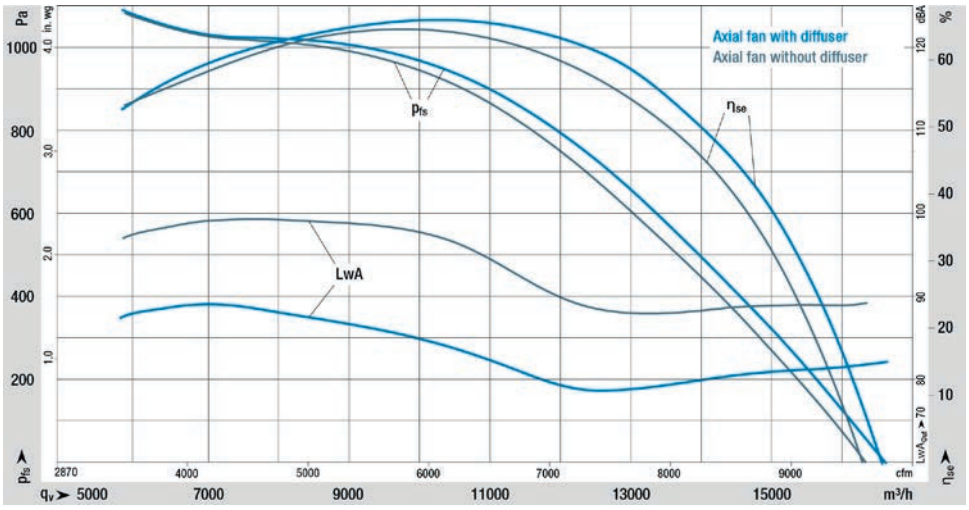

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FIGURE 3: **The figure shows an axial fan's characteristic curve with and without a diffuser.**

Blowers for High-speed Ovens

Hot air for quick cooking

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The borders between retail and gastronomy are increasingly blurry. Gas stations, supermarkets, and even clothing stores are offering their customers warm snacks. But space on the counter and hungry customers' time are both in short supply. Compact high-speed ovens solve the problem, with the help of EC blowers from ebm-papst.

The world eats out. More and more people are not cooking at home, but rather eating on the go and preferably at all times of day. When filling up the car, shopping or at a bar after work. The classic restaurant is no longer the first destination, for things have to move fast – and taste great nevertheless. The food industry has reacted: a broad spectrum of frozen products makes it possible for stores to offer an extensive menu even without a chef. The trend is clearly toward front ("on-stage") cooking: customers want to see how their food is prepared. This presumes that an appropriate and easy-to-operate device with a pre-programmed baking program is available, because pizza is supposed to be nice and crispy.

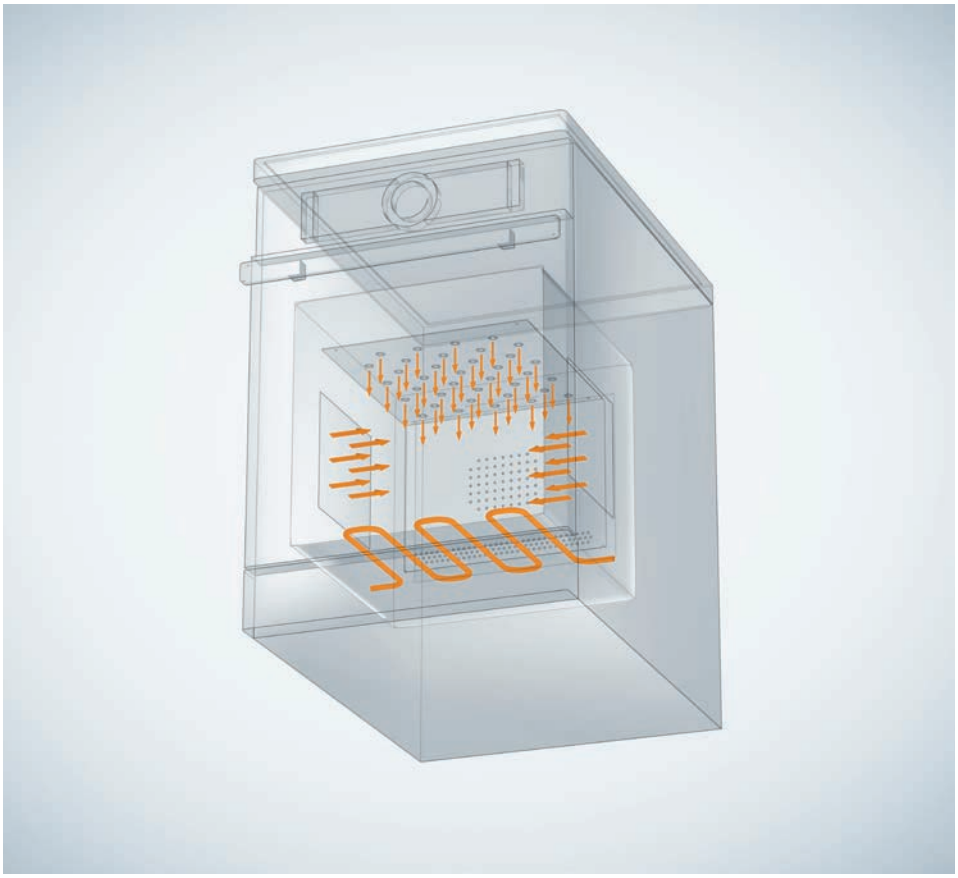
The consequence: on the shop counter, where there isn't much space, kitchen appliances have to be as compact as possible and work as quickly as possible, for preparation shouldn't take more than a minute or two. The next customer doesn't want to stand in line for long. Therefore, what's needed is a lot of power in a small space. Compact high-performance ovens are just the thing here.

Expertise from baking lines

Manufacturers rely on so-called hot-air-impingement ovens, which combine convection, radiation, and microwave technology. Hot air is blown through nozzles onto the baked goods at high pressure of up to 4,000 Pascal (Fig. 1). Temperatures of up to 450 degrees are thus possible and the pizza is nice and crispy in no time at all. Dishes can be prepared up to 15 times faster than with traditional ovens.

The technology is not new. In the food processing sector, it has long since been tested on long baking lines – however, there the space for the blowers that move the hot air plays a subordinate role. The situation is different for high-perfor-

FIGURE 1: **Efficient combination: compact hot-air-impingement ovens unite convection, radiation, and microwave technology. This keeps preparation times as short as possible.**



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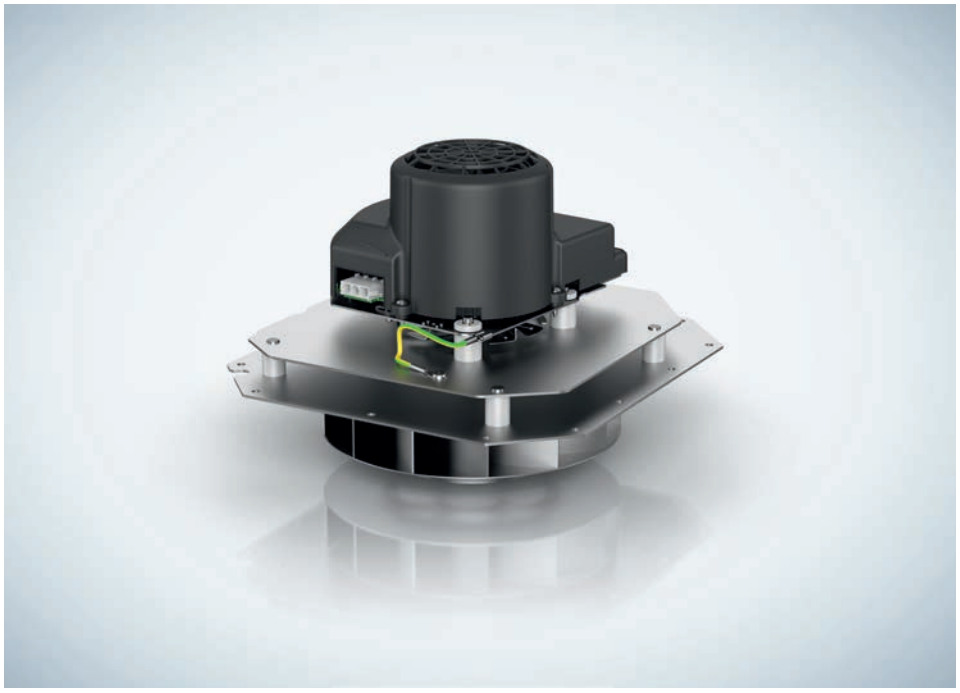

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FIGURE 2: **Lots of power in a small space: Thanks to EC technology, the VBS 170 requires only a little space. That's why it's well-suited for compact high-performance ovens.**

mance ovens for front cooking: so that they fit on the shop counter, the space for the technical components is quite limited. Here, AC technology cannot achieve a power density comparable to the EC fan.

But in the food processing sector, EC technology offers potential for process optimization thanks not only to its enormous power potential with greater energy efficiency, but also with respect to its possibilities for networking.

Great performance in a compact package

Blowers with EC technology have the advantage that they require little space yet nevertheless provide great power. Their compact size is possible because the electronics are arranged flexibly around the EC motor and also because the motor requires no variable frequency drive (Fig. 2). Therefore, blowers with EC technology are predestined for compact high-performance ovens (Fig. 3, p. 24). The VBS 170 centrifugal blower (formerly the R170) with EC motor from ebm-papst was adapted especially for use in such applications. Its speed of more than 3000 rpm and its backward-curved blades ensure great aerodynamic efficiency with low energy consumption. This makes high

ALL ADVANTAGES AT A GLANCE

The VBS 170 blower solution from ebm-papst is optimally attuned for use in high-speed ovens:

- **The EC technology unites a lot of power with a small space, which makes compact devices possible.**
- **The centrifugal fan impeller is made of stainless steel, so it fulfills the hygiene requirements of gastronomy.**
- **The motor is vibration-damped on a special mounting plate and fastened so that it is thermally decoupled.**
- **The noise emissions are low thanks to the design of the blower.**
- **Long service life even with constant use due to robust EC technology.**
- **EC systems can be networked easily, entirely in the service of GreenIntelligence.**

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FIGURE 3: **The ebm-papst blower is constructed so that it can be adjusted flexibly to the installation position in the manufacturer's device. Thanks to its high power density and compact design, highly-efficient kitchen appliances can be created.**

EC technology scores points with its long service life and low wear.

pressures with high air flow possible. The advantages are best displayed when the design of the EC blower is attuned to the flow design. That's why, on request, ebm-papst engineers work closely with manufacturers, even during the design phase. Since ball bearings are used for the blowers, there various ways to install them. A sleeve bearing wouldn't work since it can't always accommodate forces in an axial direction. Heavy, hanging or horizontal impellers would quickly wear down the bearing.

Another advantage of EC blowers is their dynamics: they accelerate very quickly to the desired nominal speed. No valuable seconds are lost when they are heating up. 16 hours of continuous operation is not a rarity with these compact high-performance ovens. For a high level of availability and correspondingly high sales of ready-to-eat foods, robust technology is indispensable. Here too, EC technology scores points with its long service life and low wear.

Heat-resistant, quiet, and hygienic

Due to their compact designs, the blower and heat source are close together in these ovens. However, the high temperatures cannot harm the technology: ebm-papst engineers have relied here on their many years' experience in the heating technology sector and decoupled the fan and motor (Fig. 4). These are on two levels that are separated by thermal decou-

pling elements. If necessary, an additional cooling impeller reduces the thermal load on the motor's electromechanical components.

This design principle also results in lower noise emissions. Because the ovens are frequently in the sales area, volume is a decisive factor. Customers shouldn't be disturbed by noise. Thanks to the decoupling, the mounting plates are spring-mounted, there are few vibrations, and structure-borne sound is correspondingly low. In addition contributing to the aero-acoustics, this means that noise is kept under control.

The fan's wheel is made of stainless steel, which does not rust in the humid-hot work environment. ebm-papst blowers therefore fulfill another important prerequisite in the gastronomy sector: compliance with hygiene regulations.

Ready for the future

Digitalization has long since arrived in the professional kitchen sector: many devices are already Internet-capable and therefore networked. Precisely for larger franchise companies, this is a big advantage, since they can program new cooking programs centrally onto hundreds of high-speed ovens and delete old programs. But that is not the only benefit of connectivity! ebm-papst's EC technology can also be incorporated easily into existing communication structures, entirely in the service of GreenIntelligence. An important prerequisite if in the future topics such as the recording and evaluation of operating states in general or predictive maintenance are supposed to become reality. ○

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FIGURE 4: **The fan and motor unit are decoupled from one another. This means the blower is well-suited for use in the high-temperature range. The decoupling elements also reduce noise emissions that contribute to structure-borne sound.**

TECHNICAL DATA

The most important facts and figures about the VBS 170 blower solution:
– Maximum power consumption: 300 W
– Nominal voltage: 230 V AC 50/60 (additional voltage ranges on request)

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Conditions like in the natural world

Good climate for top crops

Modern agriculture is unthinkable without greenhouses. They make it possible to harvest independently of the seasons. But plants only thrive in them when the air supply and distribution are perfectly regulated. AxiCool fans from ebm-papst are ideal for this task.

FIGURE 1: **Greenhouses provide summery conditions, even in winter.**

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Supermarkets have not sold by the season for a long time. Fresh and crispy tomatoes, peppers, and other produce are available in the produce section throughout the year, regardless of the season. By providing summery conditions during the winter, greenhouses are one of the things making this possible (Fig. 1, p. 27). The situation has benefits for both consumers and farmers. The latter can use greenhouses to harvest more crops and minimize risk in the process: under a protective roof, weather-related crop failures and hail damage are not an issue. In principle, with smart irrigation systems and air conditioners, plants can even thrive in places where nature would not normally allow it, such as deserts or cold regions.

A question of distribution

Unfortunately, cold or hot spots may arise over the entire greenhouse area. Only limited plant growth is possible in such places, and the plants are more susceptible to disease there. Photosynthesis and plant growth are strongly dependent on the temperature. If it is too cold, photosynthesis proceeds very slowly; if it is too warm, it comes to a stop very quickly. On the one hand, the optimum temperature that needs to be evenly distributed throughout the greenhouse depends on the type of plant. And on the other hand, a good supply of fresh air and air circulation are the keys to a good harvest – alongside the right temperature and humidity. This is why the goal is to create uniform climatic conditions with a roaming air flow by evenly distributing the air at a constant speed over the entire greenhouse.

Horizontal ventilation is a common method of evenly distributing the air in greenhouses (Fig. 2). In this method, the air is guided above the plants in the horizontal direction. As a rule, fresh air is supplied through the sides of the greenhouse. A highly innovative air supply method is the use of ventilation tubes from below (Fig. 3). This process ensures that sufficient CO_2 reaches the plants. This is particularly important since CO_2 is the base substance for photosynthesis in plants.

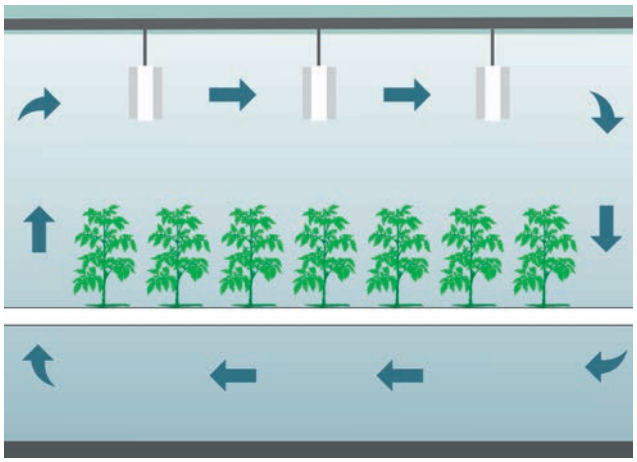

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FIGURE 2: **With horizontal ventilation, the air in the greenhouse is circulated so as to ensure a uniform temperature around the plants.**

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FIGURE 3: **With ventilation tubes, the air is supplied underneath the plants, providing an optimum supply of CO_2 to the undersides of their leaves.**

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FIGURE 4: **AxiCool fans with guide vanes on the outlet side are used for horizontal ventilation. They have a white housing to reflect as much of the incident light (important for plant growth) as possible.**

AxiCool fans from ebm-papst enable precise control of the air flow.

Solution from refrigeration technology

Greenhouse operators have the option to use a ventilation system that meets all of the plants' needs and is also easy to install. The solution uses AxiCool axial fans from ebm-papst (Fig. 4). They were originally developed for refrigeration technology since even temperature distribution is also important to keep goods fresh in cold storage rooms. That also makes them ideal for greenhouses. They feature high air throw and enable precise control of the air flow. Guide vanes are also installed on the outlet side of AxiCool fans to improve overall efficiency (Fig. 5, p. 30). The housing and mounting are white in order to reflect as much incident sunlight from the greenhouse as possible. To meet the service life requirements, the fans are specially equipped for use in the high humidity of greenhouses, and their plastic components are made of UV-resistant materials that are also easy to clean. With their aerodynamic blade design, axial fans also run very quietly – a major improvement in working conditions for the employees.

ebm-papst Inc. in Farmington, U.S.A. developed a height-adjustable mounting system for the AxiCool fans that is easy to install. It allows the fan position to be adjusted to the plant height, which changes as the plants grow. This adds up to a customized, high-power air guiding system that optimally simulates the natural movement of air.

Innovative: Air supply from below

Energy-efficient backward-curved centrifugal fans or especially high-pressure axial fans from ebm-papst are used for the tube ventilation system (Fig. 6). The air is supplied through a perforated tube installed under the plants. The axial fans intake air that has usually been conditioned (temperature-controlled and humidified/dehumidified) from the air treatment chamber of "semi-closed" greenhouses. The air is first pressed into the tube, flows upward through holes past the plants, and is then guided back into the intake air flow. The result is a defined circuit of air flow. With this type of air supply, the undersides of the leaves are optimally supplied with CO_2. This is especially efficient, since that is where the intake for photosynthesis occurs. Thanks to the high-powered fans, especially long tubes can be used. Such systems enable the implementation of efficient ventilation solutions for maximum yield in large-scale greenhouse installations such as those in the United States and also in European countries such as Spain and the Netherlands.

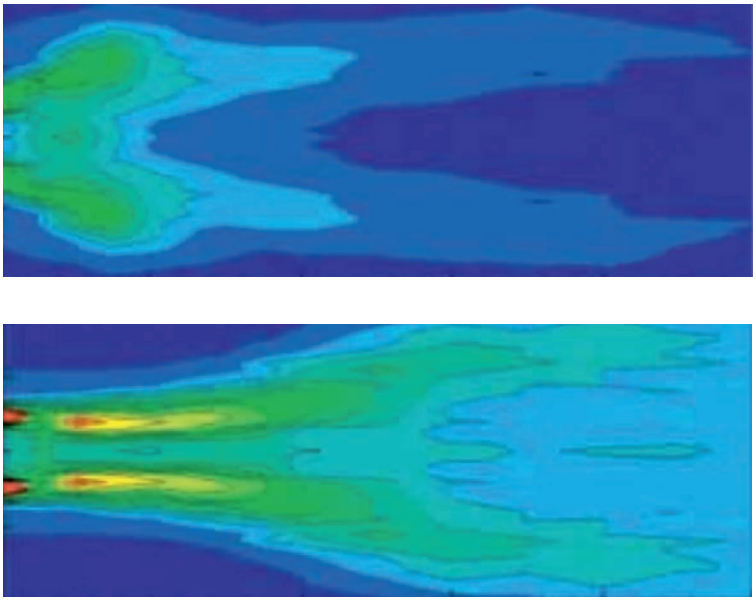

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FIGURE 5: **Above: Air flow for AxiCool without guide vanes. Below: Optimized air flow with guide vanes, doubling the air throw.**

Energy saving made easy

It is also important to have energy-saving EC motors drive the fans. These grid-fed, permanently energized, synchronous motors with electronic commutation, also called BLDC (brushless DC) motors, boast efficiencies that are far above efficiency class IE4. An innovative greenhouse design in Canada uses ebm-papst AxiCool fans and its electricity bills were reduced by more than 70% in comparison to the ventilation technology previously used.

EC motors have another advantage: their control characteristics. They can be controlled across the entire speed range while retaining their high efficiency in partial-load operation. This means that fans on smooth walls can be set to a higher speed than fans on walls with protrusions or obstacles. Air flow effectiveness can

IDEAL AIR SOLUTION

Air supply and mixing are important factors for plant growth and can be precisely controlled with axial fans from ebm-papst. Their most important advantages:

– UV-resistant white housing for maximum light reflection
– Space-saving configuration for limited shading
– Energy-efficient, maintenance-free GreenTech EC motors
– Especially quiet operation
– Fan system with on-board electronics for easy plug & play startup
– Speed control as needed via MODBUS-RTU, 4–20 mA or 0–10 V

be optimized with this precise tuning. Digital MODBUS-RTU, which use the 4–20 mA or 0–10 V interface, can be used to control the fans as needed. The MODBUS communication interface can be used to configure and monitor the fans according to the situation in the greenhouse with utmost precision. ○

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FIGURE 6: **High-pressure axial fans for tube ventilation that supplies the plants with CO_2 from below.**

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Anna
exploits the possibilities of the Industrial Internet of Things throughout the logistics and production processes.

GreenIntelligence in industrial drive technology.

Making Engineers Happy.

When we were asked what the ultimate benefit of GreenIntelligence was, we initially thought of condition monitoring and intelligent closed-loop control functions that boost operational reliability in the system and optimize the total cost of ownership. Or of entirely new IIoT features that our drive experts, with their in-depth application knowledge, develop in collaboration with our customers. But then we realized that we could also sum this up in just one simple sentence: **We make engineers happy.**

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