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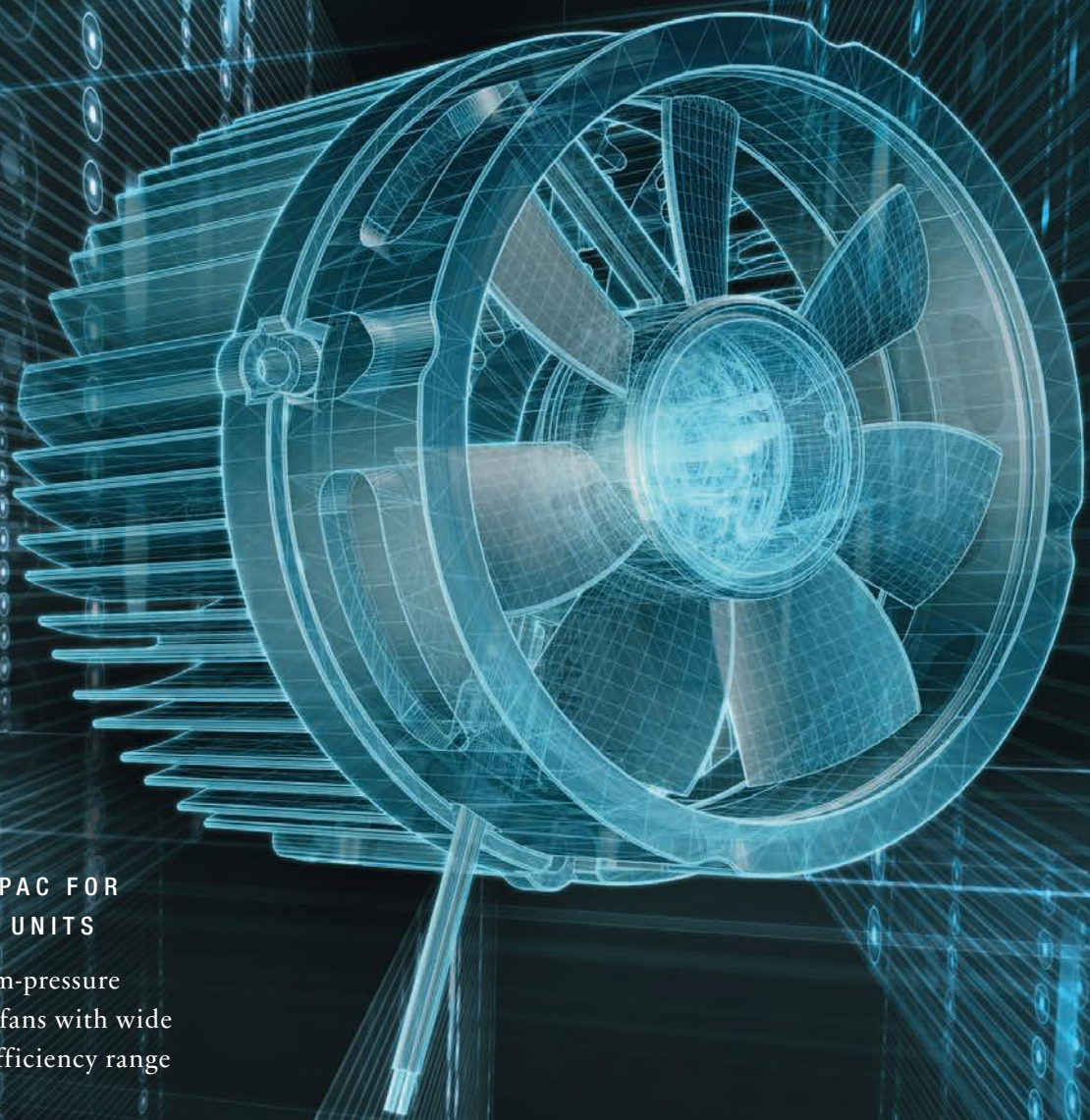
# TechMag



## RADIPAC FOR AHU UNITS

Medium-pressure centrifugal fans with wide optimum efficiency range

## PREMIX GASBLOWER

Local heating supply for high-rise complexes

## HIGH-POWER TRANSFORMERS

Robust, reliable and maintenance-free fans for cooling systems

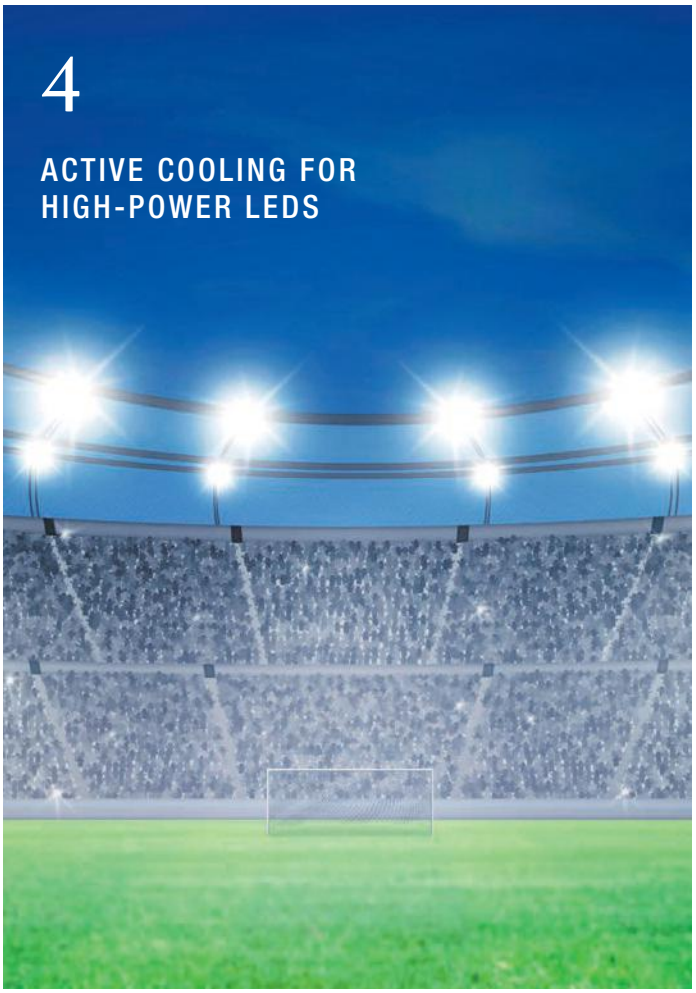
## PLANETARY GEARS

High acceleration and braking torques enables reduction in cycle times

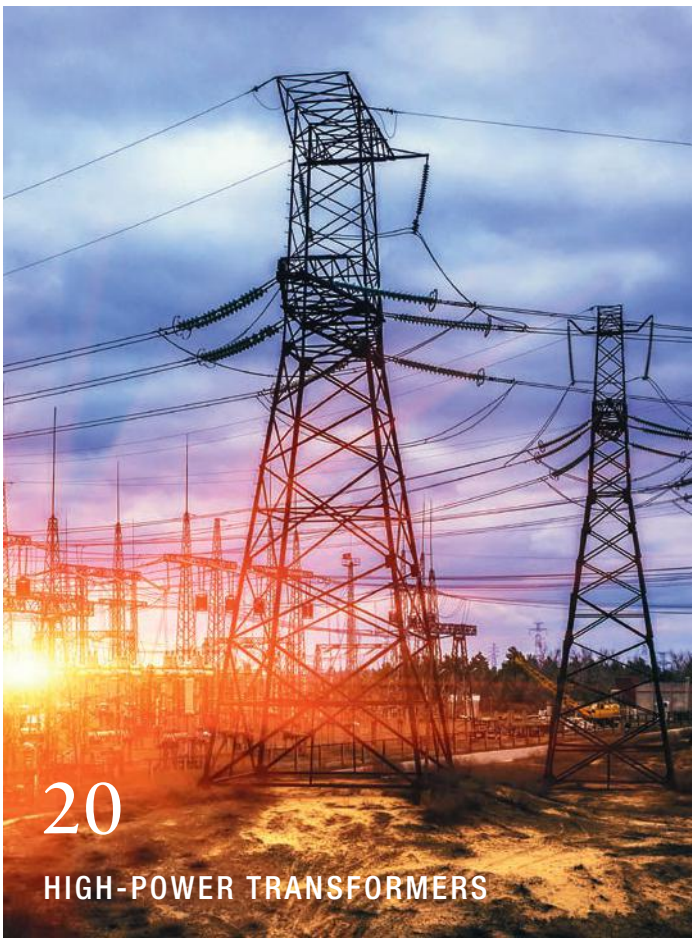
# ACTIVE COOLING FOR HIGH-POWER LEDS

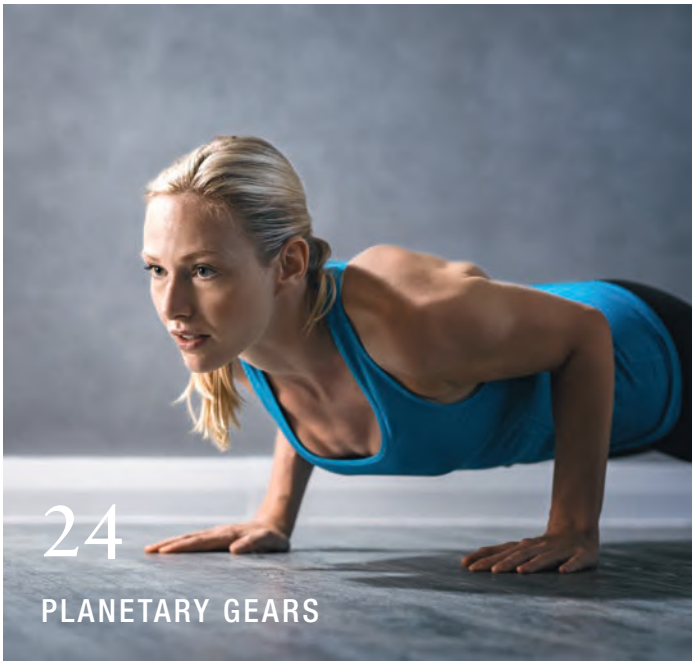
New design possibilities, longer life and better color fidelity

PAGE 4





# “Perfect Cooling for Top Performance”

**Massimo Hartsarich**

DIRECTOR BUSINESS UNIT
INDUSTRIAL FANS AT
EBM-PAPST ST. GEORGEN

*Dear Readers,*

Our higher standards regarding the economic efficiency and environmental friendliness of technical products are already having a major impact on many areas. LED technology represents tremendous progress for electrical light generation. In the same way, ebm-papst is using EC technology in electric drives and applying modern aerodynamic and acoustic tools to fan design in order to accelerate the further development of our tubeaxial fans.

To actively cool compact, high-performance LEDs, all individual components must comply with the new technical conditions regarding compactness, long service life and high power density. Of course with the same high overall efficiency level, quiet operation and environmentally compatible materials. Our motto, “The overall system is only as strong as its weakest components,” is the principle that guides our development approach. We focused on high system performance and a powerful, highly efficient unit containing a tubeaxial fan and integrated heat sink.

See the special features of this new series for yourself. In our informative lead article, learn more about the challenges of modern, active cooling for compact, high-performance LEDs. Our new, integrated fan design with a heat sink sub-system sets new standards for this application, ensuring that the overall system will be presented “in the right light” at all times.

Talk to us! Let us find solutions for your special application together. Whether it’s high-performance LEDs or a completely different application in which modern cooling concepts with tubeaxial fans from ebm-papst would be the perfect solution.

*Have fun reading the latest issue of tech.mag!*

New design possibilities, longer life and better color fidelity

# Active cooling for compact high-power LEDs

Modern lighting systems for commercial use must meet higher expectations of durability and reliability. This includes, among other things, service life, efficiency, color range, efficacy, and color fidelity as well as a compact design and ease of maintenance.

FIGURE 1:
High performance LEDs are installed, for example, in stadia.

In most cases, spot lights and flash lights with long-life LED modules in various output categories score highly. Their high luminance enables a targeted light control with overall low power consumption. As with all semiconductors, however, the waste heat has to be removed efficiently, otherwise, it leads to hazardous high temperatures despite high efficiency of the tiny LED chip area. Thanks to special LED cooling modules replacing passive heat sinks, modern cooling solutions with active air movement allow for targeted heat dissipation, alongside with size reduction and material gains. Also, completely new design possibilities can be realized, minimizing maintenance of even very complex lighting systems, such as in museums, theaters, and places of worship, storage facilities, street lighting or stadiums (Fig. 1). Active cooling opens new horizons in efficient LED lighting.

*Selecting the right light source*

The correct amount of light determines how we perceive the world. This is why there are lighting specifiers, who can make us see things "in the right light". However, it is often difficult even for experts to select the right light source. Ideally, a light source should have a universal application, requiring little space or power. CoB lights (Chip on

Panupong, fotolia

Board) meet a whole range of industry requirements. However, its semiconductor chip must have targeted cooling in order to maintain its lifetime and color fidelity. To meet the CoB requirements, ebm-papst has developed a line of active compact cooling systems specifically for the market-oriented designs of the new high-performance LEDs. It saves space and allows completely new lighting possibilities.

*LED bulbs – compact and efficient?*

When you look at the CoB in detail, you will quickly notice several problems (Fig. 2). As a semiconductor, the LED chip can only operate up to a predetermined junction temperature. Should the temperature rise, the LED quickly develops challenges. These include a reduction in CRI (color rendering index), efficacy and most importantly, a reduction in lifetime. But even at lower temperatures, the material ages rapidly, luminance and efficiency decrease, the color range reduces- in short, its useful life is down. Despite their high efficiency, the waste heat of LED surfaces and the high power density of the LED light sources can be formidable This amount of waste heat must be dissipated in a targeted manner, either by means of conventional (often oversized) passive cooling or via targeted active heat dissipation (see text on the box, page 9). In principle, the following must be considered: Energy (heat) always flows from hot to cold. For cooling solutions, the total heat resistance, i.e. the sum of individual paths of thermal resistance, must be taken into account. Here, a significant difference between passive and active cooling concept already emerges: The "cooling pathway" LED Chip – substrate – heat sink – air is always the same, but the material part of the same cooling performance varies greatly. The more material is used, the larger the heat sink-is required. Smaller LEDs with the same output and passive cooling are not yet capable of producing smaller fixture designs; because they require large heat sinks as the thermal dissipation/heat transfer to the air becomes a limiting factor for the heat transfer. Passively cooled LEDs therefore require

**ebm-papst has developed a line of active compact cooling systems specifically for the market-oriented designs of the new high-performance LEDs.**

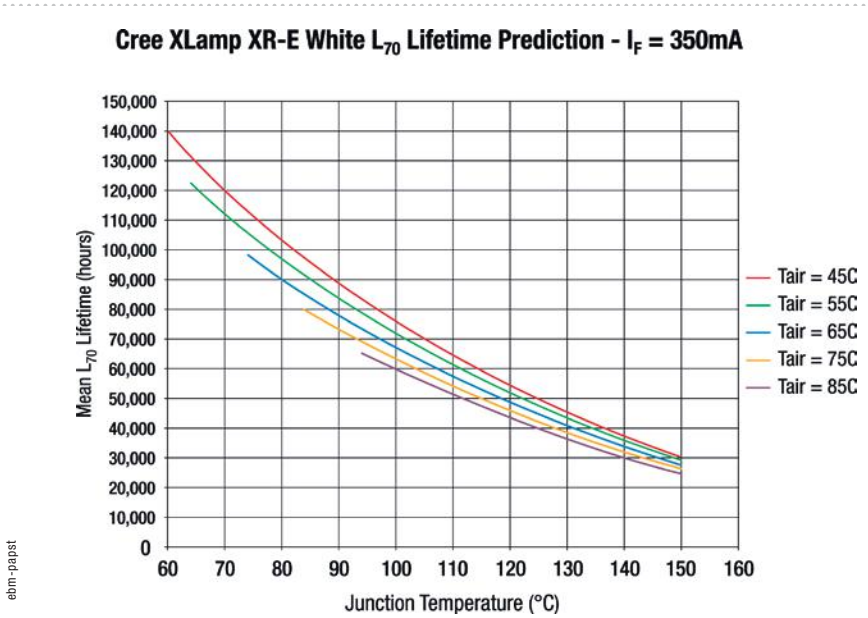



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FIGURE 2: **The life expectancy of the LED is essentially dependent on the temperature, which is why targeted heat removal is especially important.**

a high use of material and are usually neither compact nor environmentally friendly. At this point, active cooling concepts offer several distinguishing advantages (Fig. 3).

*Future-proof active cooling*

Since the heat dissipation from the heat sink to the air is the main resistance in the energy discharge, the largest cooling reserves can also be released. A key feature of active cooling is the targeted air supply to the heat sink. Forced convection, or more specifically turbulent flow is generated towards the heat sink, which considerably improves heat transfer from the thermal mass of the heat sink itself into the neighboring reservoir of air which surrounds the light fixture. Normally, the system works as follows: A small heavy-duty LED surface is attached to the heat sink with a thermal interface material. This provides a much lower thermal resistance enabling a greater transfer of heat from the LED into the heat sink, with between four- and six-fold decrease, the fan creating cold fresh air flow. The electronic cooling experts from ebm-papst St. Georgen have now combined heat sinks and fans into a compact module for common LED cooling solution designs, which makes installation easier (Fig. 4). Its smaller design also saves not only in material but also in weight, and the targeted airflow also ensures that heat transfer impairing deposits such as dust do not adhere at all.

FIGURE 3: **Active cooling solutions also impress with their compact design.**

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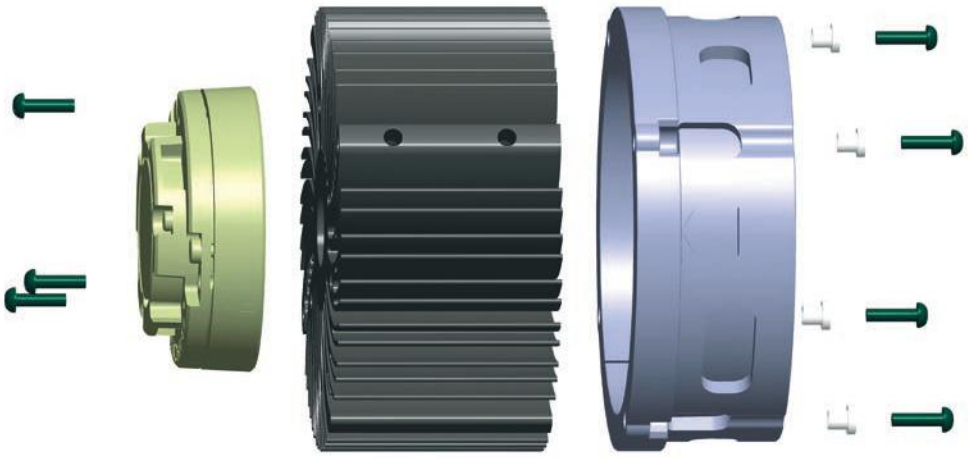

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FIGURE 4: **Heat sinks and fans can be combined into a compact module for common LED cooling solutions, which facilitates assembly.**

# Important requirements for the use of active cooling are low operating noise and a longer service life.

*Noise-free, reliable, long-lasting*

The ever-changing requirements of modern lighting LED technology demand optimizing new concepts in simulation programs with material-specific, aerodynamic and drive-specific details, where efficient, reliable cooling modules can be built in the smallest available space. A six-fold decrease in dimensions compared to passive cooling speaks for itself. Other important requirements for the use of active cooling are low operating noise and a longer service life. Most people can perceive noise starting from about 12 dB (A), the fans above reach values between 7 and 19 dB (A), whereas comparable fans available on the market start from 18 dB (A) upwards. For comparison, the noise level in an office is about 35 dB (A), so the modules are inaudible even in museums or theaters. Power consumption of the fan is between 0.18 and 1.1 W at 12 VDC. This allows the modules to dissipate waste heat reliably at between 38 and 200 Watts. Depending on the output category, round and square axial compact modules have diameters and side lengths which include 40, 50, 60, 80 or 92 or 119 mm with an overall height of 10 to 25 mm. In the radial version with air deflection at 90°, the dimensions are 51, 76 or 97 mm with the height of 15 to 33 mm. Thus, compared to passive cooling solutions comparable to the cooling capacity, 50 to 100 % higher luminance is possible with the same size. Another positive benefit of the targeted active cool-

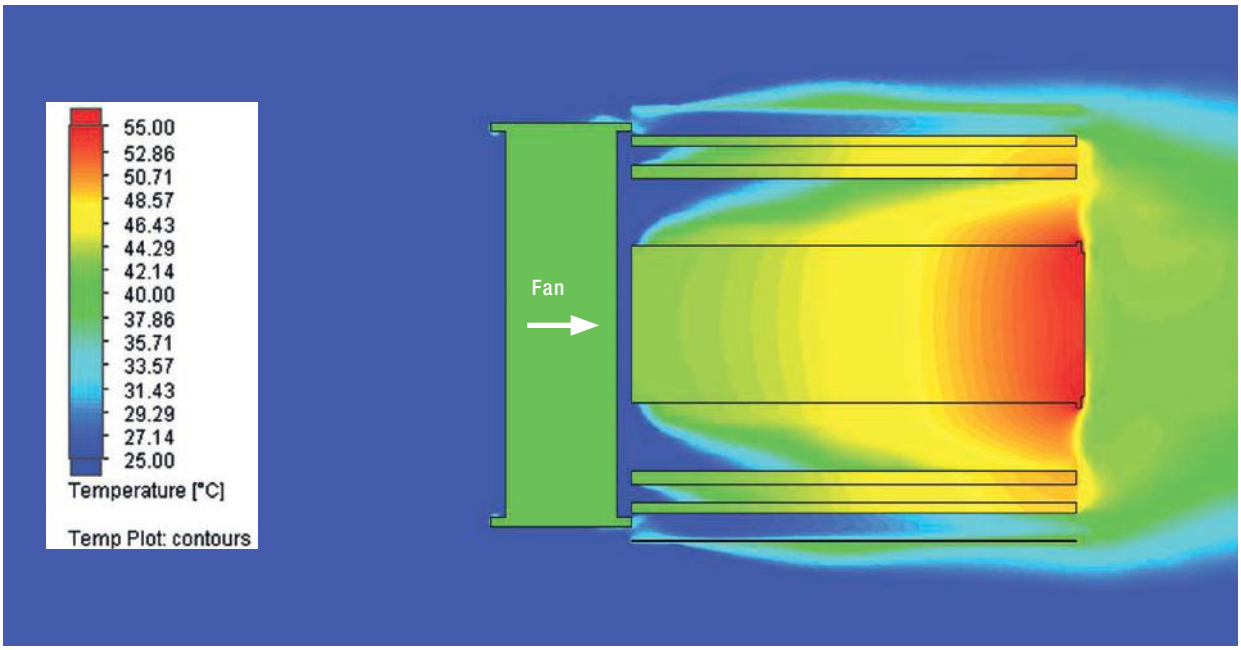


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FIGURE 5: **The picture shows how the LED heats the heat sink (red, 55 °C) and the fan blows the cool ambient air (blue, 25 °C) through the heat sink and thereby limits the maximum temperature at the LED to approx. 60 °C.**

ing is the low-temperature color fidelity of the LED arrays. Especially in museums, a high CRI is essential to see the illuminated objects in the right light. As the cooling modules were developed for worldwide maintenance-free use, their service life is comparable to the CoB light sources. At 40 °C, the value is 87,500 to 97,500 h, i.e. around 10 years; at an ambient temperature of 20 °C, the service life is doubled and can often far exceeds that of the LED itself. The green technology from ebm-papst also takes into account an environmentally compatible overall service life concept for development, production, operation and disposal.

As a result of their reduced size, modern compact modules for active LED cooling enable completely new lighting concepts, drastically shorten the time-to-market for the chip-specific designs and improve the environmental balance of the lighting concepts due to its low maintenance. O

AUTHOR IS MARTIN SAUTER, TEAM MANAGER SALES - INDUSTRIAL AIR TECHNOLOGY AT EBM-PAPST ST. GEORGEN.
YOU WOULD LIKE MORE INFORMATION ON THIS TOPIC? PLEASE ADDRESS YOUR QUESTION TO:

Martin.Sauter@de.ebmpapst.com

## ACTIVE COOLING PRINCIPLES

**The heat discharge coefficient, which is important for heat dissipation, describes the ability of the air to dissipate energy from the surface of a cooler. Among other things, it depends on the air density and the thermal conductivity coefficients of the heat dissipating material as well as the air. The thermal conductivity coefficient is usually calculated using the temperature difference of the parts involved. In contrast to thermal conductivity, the heat transfer coefficient is not a material constant, but is strongly dependent on the flow velocity or the type of flow (laminar or turbulent) as well as the geometric conditions and the surface texture. Active cooling employs more efficient heat dissipation.**

**In the case of laminar flow, the air moves in approximately parallel layers. The heat is transferred between the layers only by very slow heat conduction. Conversely, in case of turbulent flow, intensive swirling and shifting occurs. This results in an almost perfect mixing of air flows. Heat transfer in turbulent flow is therefore a lot more efficient as in the case of laminar flow, which is used in passive cooling (Fig. 5). To use an example from everyday life, a small hair dryer uses 1.0-1.5 kWatts per a blast of turbulent air. On the other hand, an electric convection heater with 1.5 kWatts builds up a lot more with a largely laminar inflow with the same output.**

m.mphoto, fotolia

Medium-pressure centrifugal fans
with wide optimum efficiency range

# Combining EC technology with airfoil blades

In ventilation, air conditioning and refrigeration applications, designers and operators often discover that the fans installed in their equipment are noisier or less energy-efficient than expected. The conditions of installation are often to blame, as they can have a negative effect on power consumption, air performance and noise emissions. The fan's impeller, motor, control electronics and housing are optimized for energy efficiency and noise emission, and the actual conditions of installation in AHUs should not be neglected.

FIGURE 1: **Having established itself in the market, the RadiPac series of centrifugal fans is adding new models again. With drive power from 500 watts to 12 kilowatts and sizes from 250 to 1,000, air performance of up to 40,000 m³/h can now be achieved.**

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Motor and fan specialist ebm-papst is putting considerable effort into developing the potential of its products. After establishing itself in the market, the RadiPac series of centrifugal fans is now expanding, with new models in sizes from 630 to 1,000 (Fig. 1). Thanks to a number of aerodynamic improvements, all of the fans in this series work with a wide optimum efficiency range and also feature other practical characteristics. With drive power from 500 watts to 12 kilowatts and sizes from 250 to 1,000, air performance of up to 40,000 $m^3$/h can now be achieved.

*Reinventing the impeller – with airfoil blades*

The efficiency of the motors is already well above the values called for by the IE4 efficiency class. But greater motor efficiency is no guarantee of an equally high overall system efficiency. Besides its motor, a fan's impeller, its housing and even its conditions of installation have to be considered when analyzing the energy situation, if all potential for saving energy is really to be realized.

With this goal in mind, the engineers at ebm-papst have performed a complete aerodynamic optimization of the RadiPac fans, focusing on the air inlet, the motor's position in the impeller, the blade profile and the impeller air channel. They designed the inlet ring for the impeller and its aerodynamically optimized blade channel. And they adjusted the motor's position in the impeller to achieve a good compromise between compactness of the complete fan unit and the most aerodynamically beneficial location for the motor in the impeller. The airfoil aluminum blades in the impellers result in greater efficiency (Fig. 2). The RadiPac Airfoil impeller is now both lighter and stiffer. They achieved a further reduction in the pressure losses at the inlet and also improved the outflow characteristics with the trailing edge and the integrated radial diffusor. This reduces

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FIGURE 2: **Starting with size 310, the impellers have the new airfoil aluminum blades for improved efficiency. The flow diagram at the right shows the pressure distribution; low pressure is shown in blue and high pressure in red.**

the deflection and pressure losses when the fan is installed in an air conditioner (Fig. 3).

*Squaring the circle – practical cubic design*

They also thought about practical ways to transport and install the fans. Sizes 630 and larger feature a stackable cubic design with clear installation benefits for the user, safety during transport, and less packaging waste. They can also be flexibly mounted with horizontal or vertical motor shaft. The design makes it possible to isolate the fan from its surroundings with rubber isolators in order to ensure even quieter operation. An optional guide profile set for simple installation of centrifugal modules with support structure and spring elements is still available. There are no grounds to fear flow losses thanks to the special design of the cube struts. Depending on the conditions of installation, the centrifugal fans are also available with the proven support brackets (Fig. 4, page 14).

FIGURE 3: **Deflection and pressure losses are reduced when the optimized fans are installed in air conditioners.**

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*Wide optimum efficiency range*

Taken together, all these measures increased the efficiency of the RadiPac fans by more than 13 % over that of the previous models. In addition, a wide optimum efficiency range with static overall efficiency of 68 % enables the fans to work with minimum power consumption at practically every operating point. There are also no unpleasant surprises when it comes to noise (Fig. 5). The planned operating point for a system may shift due to changes in the ductwork, for example. Another reason to change the original operating points could be gradual clogging of the filters in the AHU equipment. Essential for the RadiPac's wide optimum efficiency range is the ideal interplay of all fan components. With their high efficiency, simple handling and small footprints, these medium-pressure centrifugal fans excel in many ventilation and air conditioning applications.

*Power factor correction*

Generally speaking one can say that when several EC fans are operated in parallel, active PFC (power factor correction) can protect against unwanted harmonics. PFC converts the pulsed input current of the EC motors into a sinusoidal current, which is then shifted so that it is in phase with the voltage. This greatly reduces the harmonic content of the power supply, enabling the relevant requirements of EN 61000-3-2 to be satisfied without design modifications. It also minimizes the peak input current values and in many applications, users can select a smaller cross-section cable for the fans' power lines.

*Simple commissioning with plug & play*

Practical experience has repeatedly shown that in fans, modern EC drives are considerably more energy-efficient than the conventional AC drives that are still frequently used in ventilation and air conditioning equipment. Regulations such as Germany's "Energiesparverordnung" (energy conservation regulation, abbreviated "EnEV") and the ErP Directive (Energy-related Products Directive) have also done their part to increase the popularity of EC technology. Commissioning RadiPac fans with GreenTech EC technology is simple because neither expensive fine-tuning nor additional

**Measures increased the efficiency of the RadiPac fans by more than 13% over that of the previous models.**

FIGURE 4: **Sizes 630 and larger feature a cubic design. Depending on the conditions of installation, the centrifugal fans are also available with the proven support brackets.**

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grounding and shielding measures are required since the control electronics and EC motors are perfectly matched. With the smoothly adjustable speed control typical of EC motors, the fan power can also be precisely adjusted to satisfy individual needs, with communication via the 0-10 V input or MODBUS RTU.

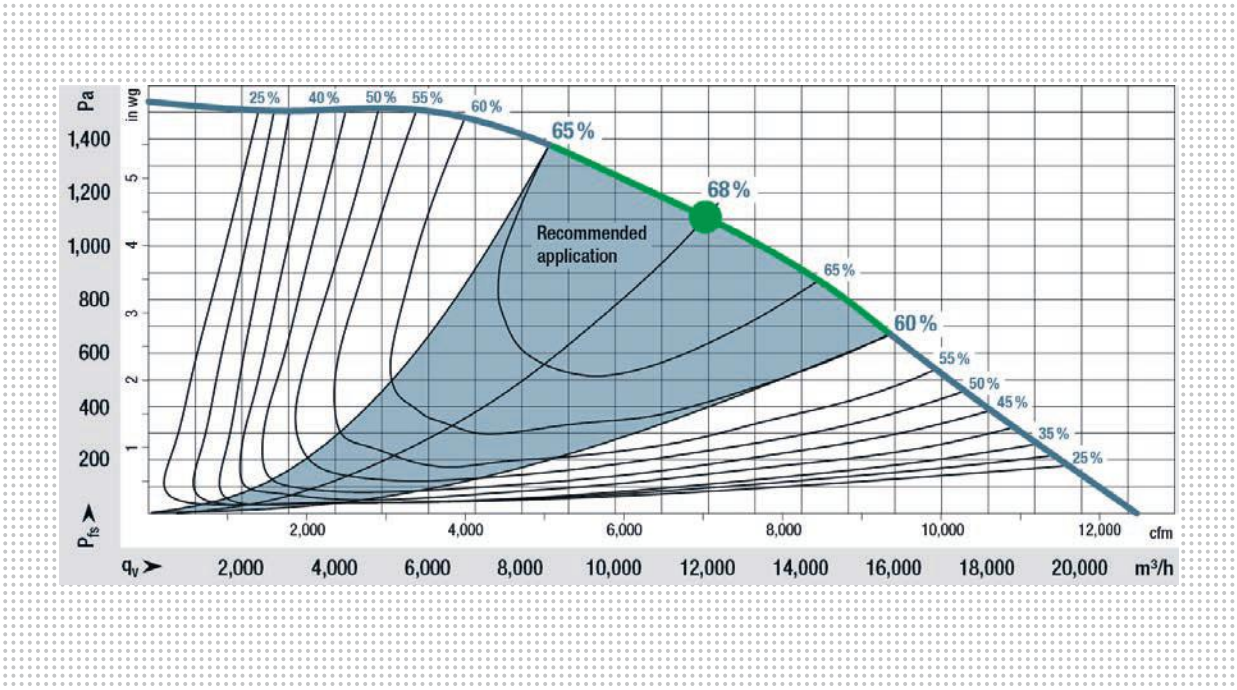


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FIGURE 5: **The wide optimum efficiency range with static overall efficiency of up to 68 % enables the fans to work with minimum power consumption at practically every operating point and prevents unpleasant noise-related surprises.**

AUTHORS ARE MICHAEL STREHLE AND JENS MÜLLER, AERODYNAMICS DEVELOPMENT AT EBM-PAPST MULFINGEN.
YOU WOULD LIKE MORE INFORMATION ON THIS TOPIC? PLEASE ADDRESS YOUR QUESTION TO:

Uwe.Sigloch@de.ebmpapst.com

**2 MW premix gas blower for natural gas heating systems in large residential and office buildings**

# Local heating supply reduces heat losses and costs

Urban areas are attractive for both office and residential buildings. At the same time, the environmental sustainability of heating systems is a pivotal issue for new constructions in metropolitan areas. A modern local heating station operated with gas premix technology can now provide up to 2 MW thermal output - equipped with a single boiler. Premix technology reduces the emission of pollutants and, in combination with an EC motor with a broad modulation range, the environmental impact is minimal.

Until now, in many cases individual large combined heat and power plants have been used outside densely built-up areas to bring hot water to the consumer by district heating supply (Fig. 1, page 18). As energy prices and environmental standards increase, this method is not always the optimal solution in light of the heat losses, at least for new constructions. Instead, the trend is moving towards environmentally friendly, on-site gas heating systems. A decisive advantage is that the energy loss that necessarily occurs over long distances with district heating despite the insulation of the pipes, is a thing of the past. The second advantage of this procedure is the savings in infrastructure. A simple gas pipe can handle a lot of energy compared to much larger district heating pipes with supply and return pipes. In addition, it is easy to see that an insulated pipeline is significantly more costly than a practically maintenance-free natural gas pipe for construction and later during operation with maintenance and repairs.

*Trend towards local heating supply*

There are other factors in favor of the trend away from conventional district heating to local heating supply (Fig. 2, page 18). From an ecological standpoint, the material balance both in construction and in the operation of heating with natural gas is significantly better than in conventional district heating concepts. Especially carbon dioxide emission is relevant to the evaluation today. Natural gas is the fossil fuel with the smallest $CO_2$ footprint and as such, it protects the climate. Furthermore, the less additional pipes that have to be laid, the faster

Elnur, fotolia

projects can be implemented. In the case of buildings like skyscrapers, on-site heating systems can save costs significantly and reduce the environmental impact. Even in the case of heat supply for residential areas, local heating supply can improve the environmental balance considerably. In addition, when new areas are being developed, the local distribution grid can be laid in the construction site quickly and on schedule without having to show too much consideration for existing infrastructure.

*Variable output improves the operating balance sheet*

Today, approximately 2 MW capacity is required to supply heating water and tap water to buildings with 50 stories or developments with approximately 100 single-family dwellings. Modern gas firing in premix technology is desirable because of its homogeneous mixture preparation at lower combustion temperatures and complete fuel utilization. Only very small quantities of unburned hydrocarbons or nitrogen oxides are emitted. In addition, a variable heat supply based on a modulating burner operation also increases the efficiency of the entire system. Therefore, precisely in boom cities with strong growth, a modern local heating supply based on natural gas is a genuine alternative to district heating in terms of the environmental footprint, economic viability, and fast construction progress.

*Reducing the cost of installation*

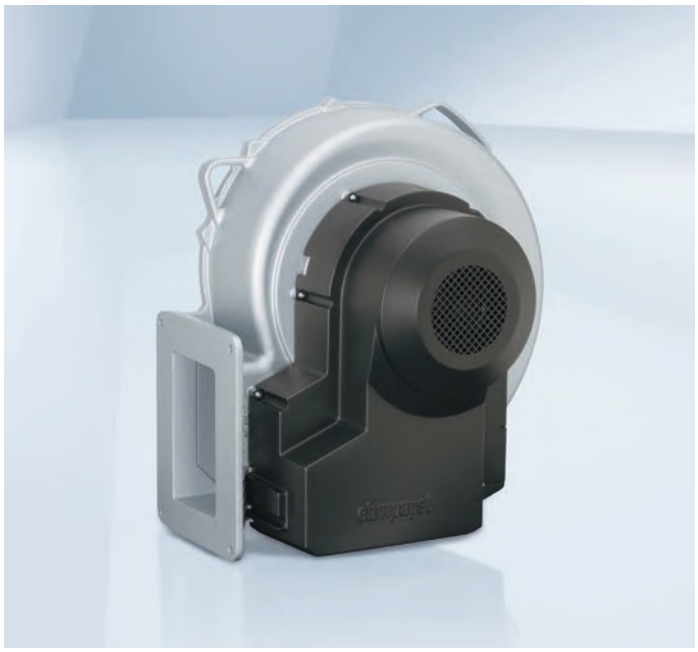
But until now, there has been one disadvantage: If larger thermal loads above 1 MW were required for single boilers, there were no suitable, highly efficient gas blowers on the market capable of being modulated over a wide range. In order to achieve these capacities, several boilers had to be installed on site to be operated in cascade. Besides the additional cost of installation, this also meant increased maintenance costs. With the new G3G 315 premix blower by ebm-papst, a broadly modulating gas blower that can be used for heating capacities up to 2 MW is now available to supply heat to larger units (Fig. 3). Of course, 2 MW boilers equipped with this blower can also be operated in cascade for even greater thermal loads. This allows the local heating supply of significantly larger high-rise complexes, such as those that are being built with increasing frequency, especially in the Asian region (Fig. 4). Thus, the investments and ongoing operating costs of heat supply by natural gas are reduced considerably.

*Good improved and adapted*

The new gas blower builds upon the many years of experience of the blower specialists. It is suited for gas condensing units and can also be used in other areas that require a lot of air, such as filtration or process air technology. In the development of this product, the specialists were able to rely on proved and tested motor components from their portfolio of blowers and adapt them to the special requirements of larger heat loads. This allowed the aerodynamics of the impeller to be matched optimally to the characteristics of the motor. A new motor/electronics configuration now allows rotational speeds up to 6,000 rpm. Together, the efficient impeller and the optimized air duct design of the fan produce a broad turn down ratio of up to 1:8 for the blower. So the blower, as the first in its class, covers an input range from 250 to 2,000 kW in one unit. That is adequate to keep up with even strongly fluctuating heating requirements economically. Addi-


FIGURE 1: **A conventional combined heat and power plant for district heating requires high investments in distribution grids with considerable heat losses over longer distances.**


FIGURE 2: **Compact local on-site heating stations are an ecological solution for large buildings as well as for residential areas.**



ebm-papst

FIGURE 3: **The new G3G 315 premix blower by ebm-papst Landshut offers a thermal output that can be modulated between 250 and 2,000 kW.**

tional gas blower burners are under development for even greater heating capacities and will soon push the power limit of modulating gas premix boilers even higher.

In addition to the efficiency of the burning, easy integration in modern control systems was also a development objective. Thus, a standardized interface in the motor controller allows the transmission of all important data via a PWM or 0-10 V signal or Modbus RTU, for example. With 380 to 480 VAC and 50/60 Hz three-phase current, the G3G 315 requires up to 4,300 $m^3/h$ (in open-jet operation) and builds up a maximum back pressure of 6,200 Pa (at full throttling) (Fig. 5). Here, the flow medium temperature may be up to 50 °C and the maximum permissible motor ambient temperature is 60 °C. The power consumption of the GreenTech EC motor is up to 6 kW. The housing and fan impeller of the blower measuring 530 x 550 x 365 mm (L x W x D) are made of aluminum. A robust cover protects the motor and the electronics.

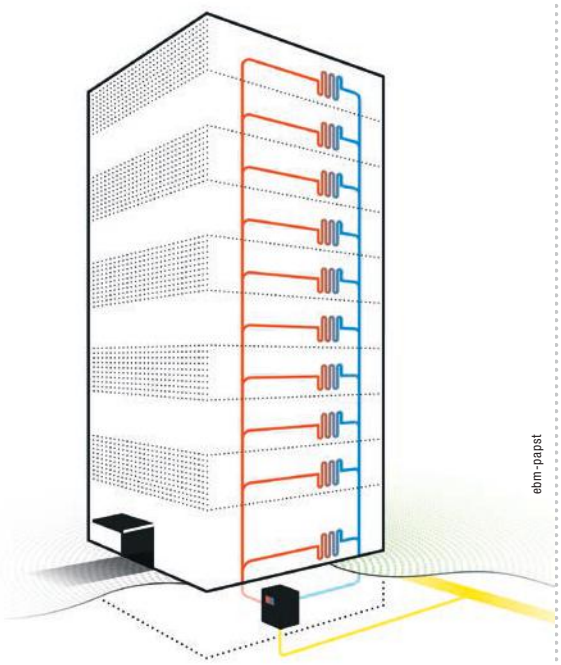


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FIGURE 4: **For large buildings, a local heating supply on site (e.g. in the basement of a high-rise) can save costs significantly and reduce the environmental impact.**

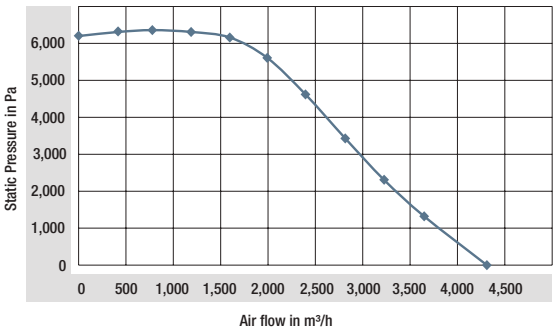


FIGURE 5: **The G3G 315 requires up to 4,300 $m^3/h$ (in open-jet operation) and builds up a maximum back pressure of 6,200 Pa (at full throttling).**

AUTHOR IS CHRISTIAN DIEGRITZ, HEAD OF PRODUCT MANAGEMENT, MARKETING AND COMMUNICATION AT EBM-PAPST LANDSHUT.
YOU WOULD LIKE MORE INFORMATION ON THIS TOPIC? PLEASE ADDRESS YOUR QUESTION TO:

Christian.Diegritz@de.ebmpapst.com

Robust technology in demand

# Fans for oil-cooled high-power transformers

Lumppini, fotolia

High-power transformers are basic components of electrical power supply systems. They switch AC voltage between different voltage levels, which makes them essential for electricity generation, transmission or distribution in power plants, industrial operations and electrical substations. High-power transformers are set up outdoors. There, they have to resist the wind and weather – and the moisture in rain forests, salt spray on the coast, blazing heat in desert regions or icy cold at the poles. The fans used in the cooling systems have to be just as tough. Robust technology that works reliably and does not require maintenance is in demand. Every time a transformer has an outage, this has fatal consequences since the power supply can no longer be guaranteed.

Transformers generate waste heat when they are in operation and oil is the coolant of choice. It transfers the heat through convection (or supported by pump systems) to the transformer housing, which has cooling fins or radiators similar to heat exchangers on the outside. Large high-power transformers require additional cooling: fans that prevent damage from overheating despite cooling surfaces that are as compact as possible (Fig. 1). The fans have to satisfy special requirements so they can withstand harsh outdoor deployment conditions.

*Fans turn transformers into energy savers*

It isn't enough for fans to support the required air performance. Properties such as corrosion resistance even in high humidity, no-maintenance operation without lubrication, and reliable functioning over as long a service life as possible are just as important. And when loads fluctuate, it is also beneficial when the cooling capacity can adjust to actual demand. It does not always make sense to switch off individual fans when the transformer is in partial-load operation because in this state, uncooled "hot spots" can arise on the heat exchanger. If the fans are operating as efficiently as possible, over the years, users can save significant amounts of money and power, which they can feed into the electricity grid. This results in a positive economic benefit for energy operators. If the transformers are near or even in residential areas, the noise they generate plays a role that should not be underestimated either.

ebm-papst Mulfingen, the motor and fan specialist, has addressed this issue by developing special transformer fans (Fig. 2). They satisfy all the requirements for sophisticated

**If the fans are operating as efficiently as possible, over the years, users can save significant amounts of money and power.**

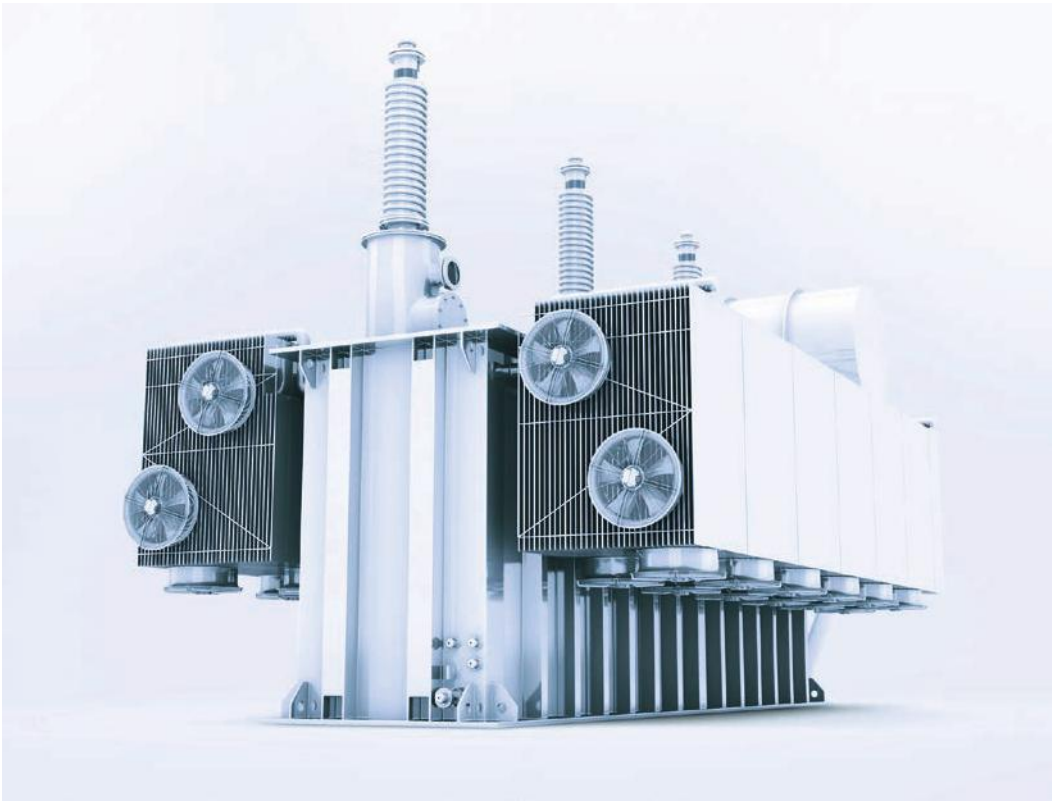

FIGURE 1: **The fans used in the cooling systems of large transformers must withstand harsh conditions. Here, robust technology that works reliably for decades and does not require maintenance is in demand.**

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FIGURE 2: **The transformer fans satisfy all the requirements for sophisticated large transformer cooling and come in sizes ranging from 500 mm to 1,250 mm.**

large transformer cooling as per DIN EN 50216-12 "Power transformer and reactor fittings – Part 12: Fans" and come in sizes 500 mm to 1,250 mm with air performance of up to 13 $m^3/s$. Their development is based on decades of experience and intense research supported by extensive simulations and tests. They also satisfy special requirements with regard to long service life and salt spray resistance (corrosion protection class C5M as per DIN EN ISO 12944), so the fans are suitable for deployment in coastal areas with high salt contents.

*Fan housing increases fan efficiency*

All the components of the plug-&-play-compatible modules – the fan housing, HyBlade® impeller, GreenTech EC motor with integrated electronics or AC asynchronous motor and intake-side guard grille – are perfectly harmonized. For example, aerodynamic optimization reduces both air turbulence and operating noise. The two motor types satisfy the requirements of the current ecodesign directive.

The impeller has an aerodynamically ideal form based on combining an aluminum frame with a covering of glass-fiber-reinforced plastic. This reduces the noise it produces dramatically, enabling higher efficiency in comparison to traditional blades.

The motor mount, which also has a contact protection function, is installed on the intake side. On the outlet side, a guard grille is also available as an accessory. Both the guard grille and the fan housing are made of hot-dip galvanized sheet steel with an extra coating. The outlet side also has an integrated circumferential flange for direct attachment to the radiator. Especially when the fans function with free air

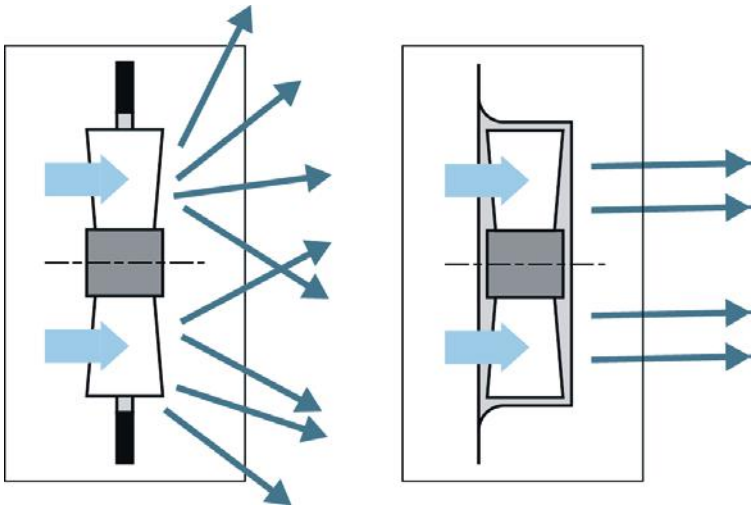

FIGURE 3: **Axial fan installation without a fan housing means major airflow losses (left). A fan housing can significantly increase air performance in the operating range.**

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## Companies that rely on proven GreenTech EC technology are taking one more step in the direction of energy efficiency.

(as usual in the case of oil-cooled transformers), the positive effect of this type of fan housing is excellent (Fig. 3). It keeps air turbulence to a minimum, increasing the airflow rate and therefore, fan efficiency (Fig. 4).

*Speed control for needs-based cooling*

Companies that rely on proven GreenTech EC technology are taking one more step in the direction of energy efficiency. EC motors are basically synchronous motors with permanent magnet excitement. In them, a rotor with integrated permanent magnets synchronously follows the rotating field of the stator, which is generated electronically. The control electronics enable infinitely adjustable air performance (linear to the fan speed), which deviates from the grid-synchronous frequency in partial-load operation at practically the same high level of efficiency. The open-loop speed control can either be specified analog via 0-10 VDE (e.g. oil temperature or oil pressure sensor) or digitally with a PWM or MODBUS signal. When MODBUS is used, several fans can be conveniently interconnected. This facilitates the use of diagnostics and monitoring functions, which ultimately contribute to reliable operation. This set up means the entire system can be operated more economically and has a positive effect on the life cycle costs.

To prevent hot spots on the heat exchanger after individual fans have been switched off, ebm-papst recommends using all fans in partial-load operation. The consequence is a more even flow through the radiator. A positive side effect: the motor does not heat up as dramatically, which extends the fan's service life.

Another aspect of partial-load operation is the high reduction in energy consumption and operation noise as a result of the physical laws. The electrical input power is

proportional to the fan speed to the third power (Pe ~ $n^3$). As a result, it is only 12.5 % when the speed and in turn, the air performance, are reduced by 50 %. Logarithmically, this reduces the noise level by 15 dB (Fig. 5).

Partial-load operation not only saves energy and lowers operating costs, but also results in less waste heat. This is especially valuable for cooling applications because heat that is not generated does not need to be dissipated. Commutation and the stator design also ensure very smooth operation. The cycle frequencies are acoustically imperceptible and noise reduction drops. This makes these "stealth fans" ideal for applications in which the noise protection regulations must be observed.

*Simple commissioning and worldwide use*

Practice-oriented design details simplify transformer fan commissioning. For example, it is possible to install and mount directly on the fan housing with a horizontal or vertical installation position as required. The motor terminal box for supply connection and control is easily accessible and isolated from the motor electronics. The development team made a point of using high-quality terminals. The fans are perfectly designed for worldwide use. They function on power supplies between 200-240 V and 380-480 V (for 3-phase 50 Hz and 60 Hz grid frequencies), satisfy all the relevant standards (UL, CSA, EAC and CCC) and the requirements of degree of protection IP55, and the rating label satisfies DIN EN 50216-12 ("Power transformer and reactor fittings" – Part 12: Fans). ○

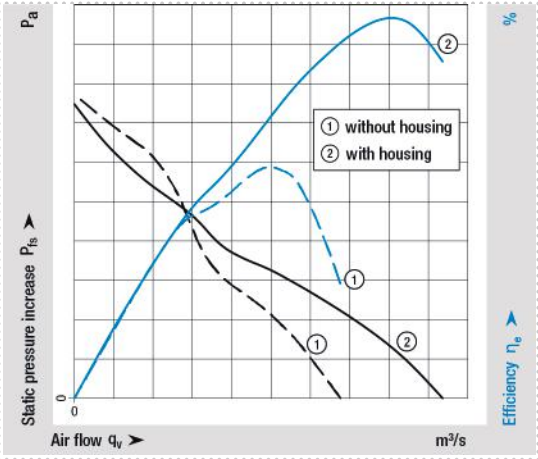


FIGURE 4: **Fans with a fan housing deliver higher air performance and higher efficiency, which leads to significantly better system efficiency (1) in comparison to fans without a fan housing (2).**

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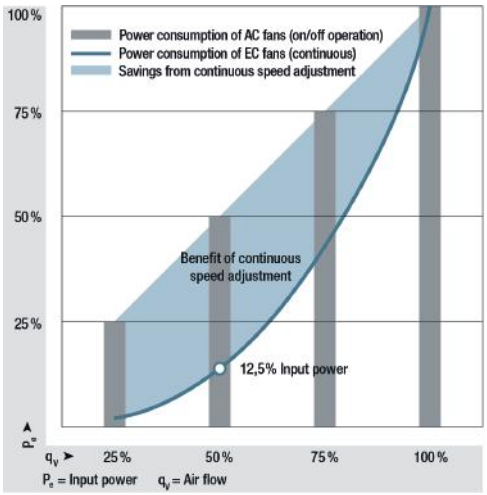
AUTHOR IS ANDREAS SCHNEIDER, PROJECT ENGINEER AT EBM-PAPST MULFINGEN
YOU WOULD LIKE MORE INFORMATION ON THIS TOPIC? PLEASE ADDRESS YOUR QUESTION TO:

Andreas.Schneider@de.ebmpapst.com



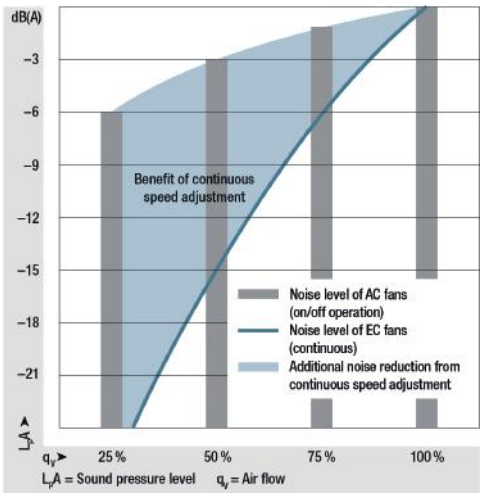




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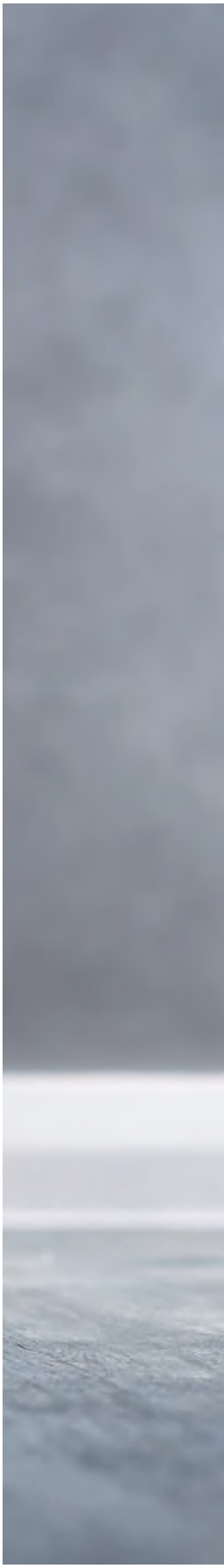
FIGURE 5: **The graphics show the potential energy savings and noise reduction in a direct comparison of on/off operation and infinitely variable speed adjustment.**

Transmissions can be combined with motors from the series ECI 63 and ECI 80

# Advanced planetary gear head for the most demanding requirements

ebm-papst is further extending the product range of electrical drive systems for industrial applications in a sustainable manner. Gear heads are playing a vital role in this, as they are a necessary part of most customer applications.



For many years, ebm-papst Zeitlauf has been recognized for its expertise in the field of gear technology, particularly in the planetary gear segment (Performax and Noiseless series). These are noted for their exceptional performance and very smooth and quiet operation. In the industrial drive technology sector, market requirements in terms of engineering are currently developing in two directions. Firstly, the functionality of drive units needs to be extended in order to speed up the design and realization of the customer applications. Secondly, the power output within a given installation space needs to be increased further, particularly in the dynamic range. In order to be able to achieve this latter requirement, the necessary peak power in each individual module of a drive unit (gear head, motor, and electronics) must be significantly increased.

*Requirements in terms of robustness and overload capacity*

This means, for electronically commutated internal rotor (ECI) motors, that higher starting torques are required together with simultaneously reduction of rotor inertia moments, in order that the dynamic response is significantly improved. This is a great challenge, particularly for the gear head. To meet the needs for higher output and mechanical robustness, specialist transmission suppliers place great emphasis on optimized design of the gear toothing and the output shaft bearing, combined with selection of the materials used. Both in terms of

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FIGURE 1: **The Optimax 63 is a highly efficient planetary gear with high overload capacity.**

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robustness and overload capacity, ebm-papst meets these requirements with the new Optimax series (Fig. 1). The first size of the series available will be the Optimax 63 gear head with an outer dimension of 63 mm.

This is where the many years of experience in gear tooth design for planetary gear heads really makes a difference. It is not just down to the teeth size (the "modulus") or selection of the teeth ratios, the rolling behavior design of the gearwheels in the gear head is also critical. Due to the possible degrees of freedom in design of a gearing, the development engineer has, at the outset, a virtually unlimited number of potential approaches to a solution at his disposal. The skill lies in the ability to find the perfect "setting" within all these potential options. The focus in the case of the Optimax, was placed on the requirements to withstand high continuous torques and a tolerance to transitory shock loads. In addition, it was also necessary to take a comprehensive view of the Optimax series and to structure it intelligently, both in terms of multiple use of components and a strategically favorable series of gear reductions (Fig. 2).

*Four instead of three planetary gears*

In order to be able to transmit as much power as possible, gear wheels with a very large width are fitted in the Optimax gear heads, which as a result, minimizes the surface pressure

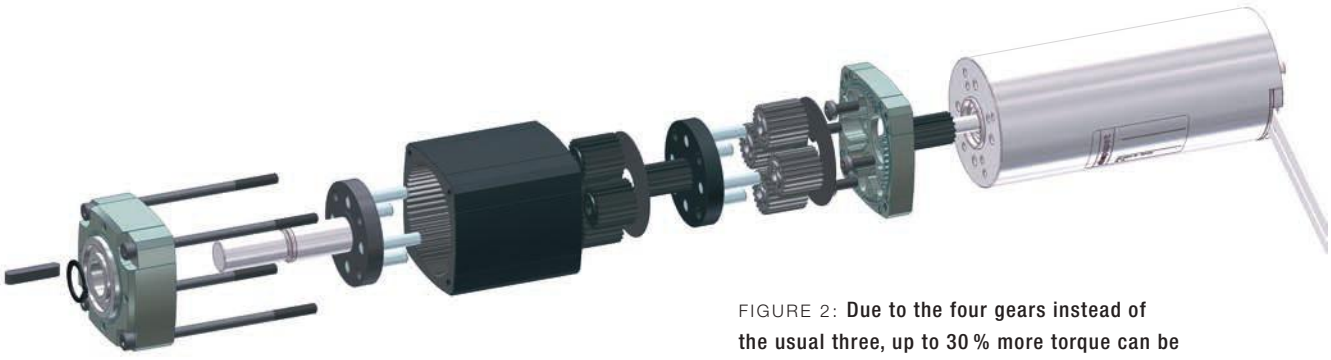

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FIGURE 2: **Due to the four gears instead of the usual three, up to 30 % more torque can be transmitted.**

FIGURE 3: **The table provides an overview of the different versions of the Optimax transmission with the associated data.**

| Nominal data/Gearhead data | | | | | | | |
|---|---|---|---|---|---|---|---|
| Typ | | 63.1 | | | 63.2 | | |
| Ratio/number of stages | i/number of stages | 3:1 / 1 | 5:1 / 1 | 9:1 / 1 | 15:1 / 2 | 25:1 / 2 | 45:1 / 2 |
| Efficiency | % | ≥ 90 | ≥ 90 | ≥ 90 | ≥ 81 | ≥ 81 | ≥ 81 |
| Output torque (Mab)* | Nm | 40 (13) | 40 (13) | 25 (6) | 68 (58) | 68 (58) | 58 (27) |
| Short-term torque (Mmax)* | Nm | 120 (39) | 120 (39) | 75 (18) | 150 (150) | 150 (150) | 150 (81) |

* Values without brackets are valid for the planetary wheels (first step) made from high-strength steel.
Values in brackets are valid for planetary wheels (first step) made from high-strength plastic.

## The Optimax gear head has four planetary gears in a single gear stage, instead of the usual three.

and wear on the tooth flanks, despite high torques, and in turn leads to a long service life. Another special feature of the Optimax gear head is the installation of four planetary gears, in a single gear stage, instead of the usual three. This allows some 30 % more torque to be transmitted, due to the power distribution over four planetary gears.

*Using corner regions with installation space*

The performance capability of a gear head, (i.e., the amount of torque that can be transmitted) will, of course, always be measured relative to its size and space requirement. This has also been taken into account in designing the Optimax gear head: With a near square cross-section, the flange size of 63 mm is best utilized with a large ring gear. The corner regions within the installation space are used for screwing the gear parts together. The gear head output shaft is mounted in two ball bearings; with particularly large bearing races for radial loads of up to 500 N (for a service life of 20,000 hours). Both flanges engage positively with the ring gear teeth, which ensures both the alignment of components relative to each other, and torque bracing among the casing components (intermediate flange, ring gear and casing flange). The function of the axial screws used, is therefore limited to bracing of the casing parts against each other.

Almost all the parts in the Optimax gear head series are designed for a near net shape manufacturing process. By intelligent use of sintering, zinc die-casting and plastic injection molding technology, it has been possible to manufacture all the components at optimized costs and with the required properties: From noise-absorbing planetary gears made in plastic for the first gear stage, or alternatively

FIGURE 4:
**As a result of the ebm-papst modular principle, the Customer can configure the drive system themselves. The transmissions offered in the Optimax 63 series can be combined with motors from the series ECI 63 and ECI 80.**

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## The robustness and overload capability of the Optimax gear head, allows high acceleration and braking torques to be realized.

high-strength planetary gears in sintered steel for use in the overload range; to a robust, wear-resistant ring gear made of hardened sintered steel and complex flange and casing geometries made as zinc die-castings with high dimensional stability.

*Deviations from the standard design are possible*

By using near net shape parts and production technology that has been perfected over many years, the gear heads can be offered at fully competitive prices, both for smaller batch sizes and for large series production. The materials and lubricants used allow operation over a wide temperature range (-20 to + 90 °C). The standard version is offered with protection class IP 50, but higher protection classes up to IP 65 can be implemented by design and can be easily achieved by additional measures. Despite the high proportion of near net shape parts, a great deal of flexibility is still retained: deviations from the standard design are possible through the use of machined planetary and sun gears. Furthermore, output shafts can be adapted to the customer interface.

*High acceleration and braking torques enables reduction in cycle times*

The robustness and overload capability of the Optimax gear head, allows high acceleration and braking torques to be

realized, which enables a significant reduction in cycle times for customer applications. The Optimax standard reductions, in the single-stage range, go from 3:1 to 5:1 (preferred type) and up to 9:1. The two-stage design is available with reductions of 15:1, 25:1 (preferred type) and 45:1 (Fig. 3). The Optimax 63 series gear heads can be equipped with powerful, overload capable ECI 63 and ECI 80 series motors (Fig. 4). These drive solutions are characterized by high overload capacity and high output performance. In terms of functionality, compactness, overload capacity and efficiency, a drive unit based on the ECI 63 K4 motor and the Optimax 63 gear head should be more than capable of meeting any customer requirements. Those interested to learn more can view the documentation for the new drive solutions (technical data, drawings, and 3D models) in the ebm-papst Zeitlauf online portal, and print or download them as required. Of course, the Optimax 63 preferred types are now included in the online portal and are ready for dispatch within 48 hours from receipt of order. O

AUTHOR IS STEFAN RÖTZER, MARKET MANAGER INDUSTRIAL DRIVE TECHNOLOGY AT EBM-PAPST ZEITLAUF.
YOU WOULD LIKE MORE INFORMATION ON THIS TOPIC? PLEASE ADDRESS YOUR QUESTION TO:

Stefan.Roetzer@de.ebmpapst.com



# Imprint

ebm-papst Mulfingen
GmbH & Co. KG
Bachmühle 2
74673 Mulfingen
Phone +49 (0) 7938 81-0
Telefax +49 (0) 7938 81-110
info1@de.ebmpapst.com

ebm-papst St. Georgen
GmbH & Co. KG
Hermann-Papst-Straße 1
78112 St. Georgen
Phone +49 (0) 7724 81-0
Telefax +49 (0) 7724 81-1309
info2@de.ebmpapst.com

ebm-papst
Landshut GmbH
Hofmark-Aich-Straße 25
84030 Landshut
Phone +49 (0) 871 707-0
Telefax +49 (0) 871 707-465
info3@de.ebmpapst.com

www.ebmpapst.com

*Responsible for content:*
Kai Halter

*Editor:*
Katrin Lindner

*Layout and production:*
Scanner GmbH, Künzelsau

*Print:*
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