02°2016

techmag°

Technology by ebm-papst

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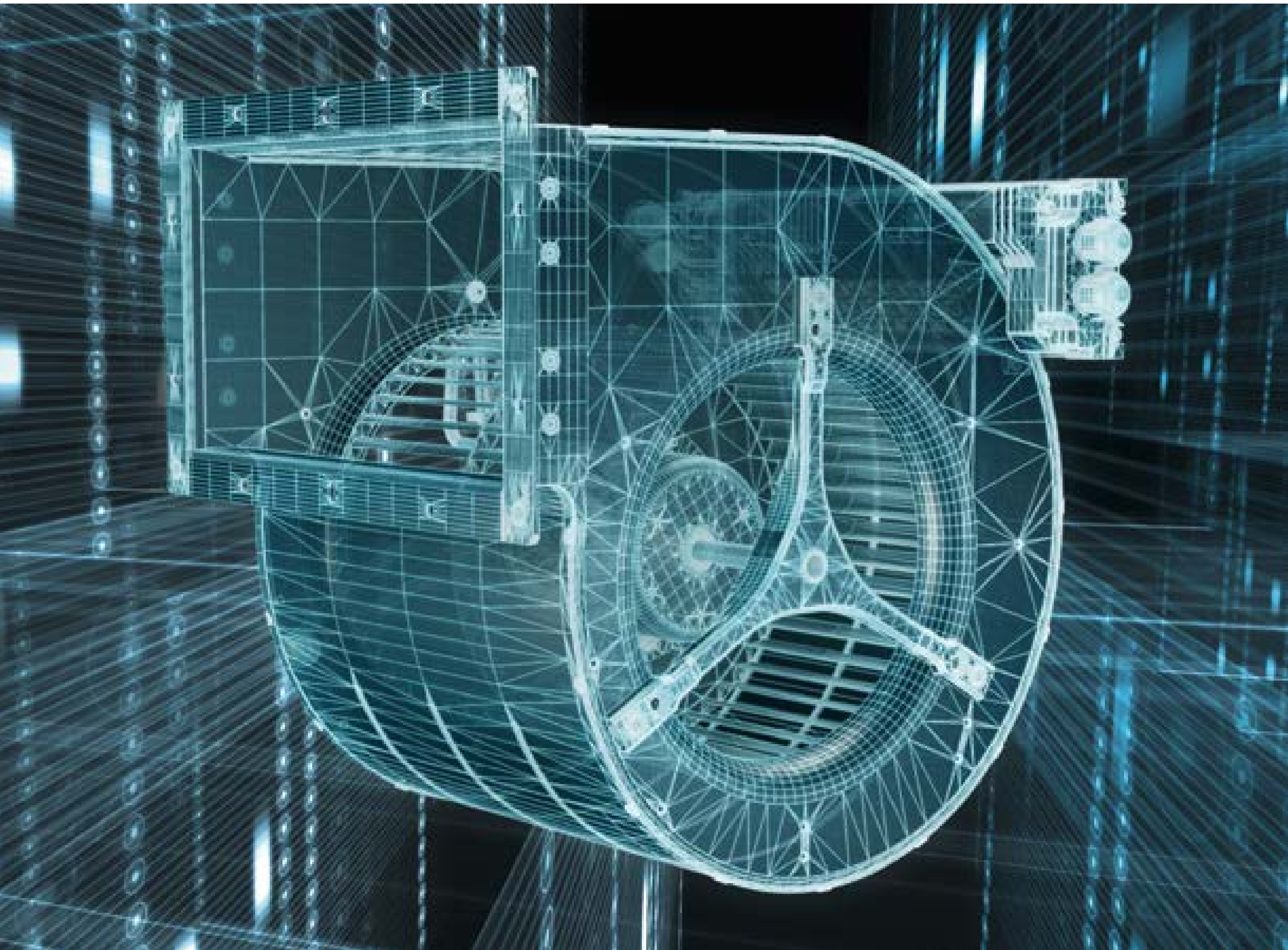

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"There's still life in them..."

Dear Customers, Partners and Friends of ebm-papst,

From a physical point of view, centrifugal fans with backward-curved blades are the most efficient flow machines. Accordingly, other fan impeller geometries ought to disappear from the market. But they don't, because top efficiency levels aren't the only criterion for choosing the right fans. Other characteristics are often just as important as efficiency. Sometimes a compact design – in other words, a high power density – can be crucial, or perhaps an acceptable noise level.

With this in mind, we've taken a new look at our blowers with forward-curved blades and breathed new life into them with powerful and highly efficient EC motors. Now we will be able to supply a product that complies with the Ecodesign Directive and can be used in applications where limited space is available.

The situation is quite different for data centers, where energy efficiency is the number-one factor influencing decisions. To select the most efficient air circulation concept, one needs dependable data that's easy to retrieve and ultimately accurate as well. Using such data embedded in our flexible FanScout software package allows informed business decisions to be made on the basis of expected lifecycle costs. Whether for axial or centrifugal fans, or for single fans or multiple fans operated in parallel in a FanGrid, FanScout can always find the most efficient combination. Who would want to find out later, when the fans are in operation, that their operating costs, which make up over 90% of their lifecycle costs, are out of control?

Lean back, relax, and enjoy reading our new tech.mag and getting inspiration from the technical solutions described there.

Uwe Sigloch, Head of Market Management for Ventilation and Air Conditioning at ebm-papst Mulfingen

Rapid start-up in only 3-4 seconds

EC centrifugal blower with high power density

To date, typical uses for modern EC fans have mainly included applications involving continuous operation, such as ventilation and air conditioning. For some time now, users have benefited from high efficiency, economical energy consumption and the associated low operating costs, plus low noise generation. However, there are many applications that require the fans involved to get up to speed more rapidly. AC fans were typically used in these applications, but since 2015 they often no longer meet the applicable requirements of the ErP Directive (ecodesign directive). For these applications, there is now an alternative that complies with the ErP directive: energy-efficient EC centrifugal blowers that not only start up rapidly but also offer other benefits.

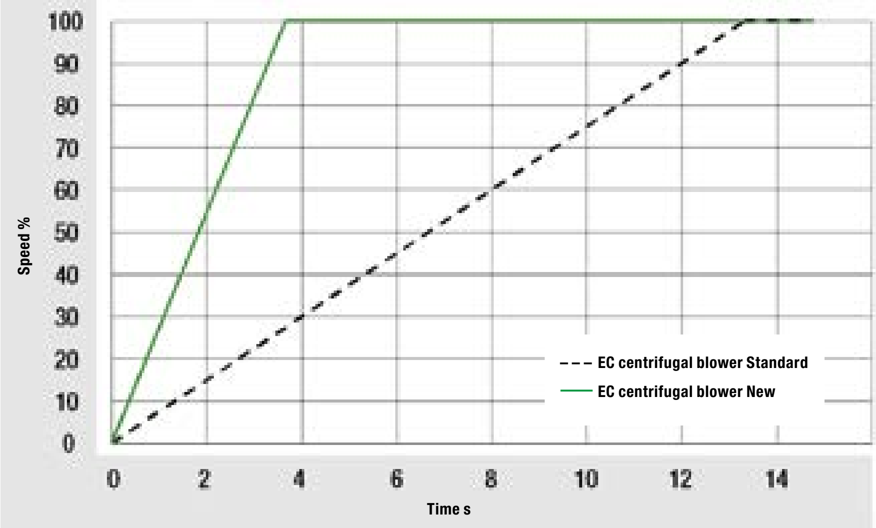

Figure 1: The new EC centrifugal blowers start up just as rapidly – in only 3-4 seconds – just like the AC variants.

The classical ventilation and air conditioning applications do not necessarily rely on rapid start-up. Instead, soft-start functions – a gentle, hardly perceptible start – are in demand. But this does not mean that EC fans cannot start up rapidly. If the control electronics are optimized for a steeper ramp-up curve, even EC motors can get up to speed within a very short time (Figure 1). For example air locks, including the ones before clean rooms in electronics production and air curtains in truck loading docks, are an application that requires rapid start-up of fans (Figure 2). But centrifugal blowers are also used in cooling systems, power electronics and kitchen exhaust hoods.

High air performance + low power consumption ebm-papst Mulfingen, the motor and fan specialist, has developed a new line of EC centrifugal blowers (Figure 3). They get up to speed at least as fast as the usual AC variants, but are considerably more energy efficient and function more quietly. The "heart" of these brisk high performers is a GreenTech EC motor with an output of 0.75 kW, with a size range of 160-250. Despite their compact size, the centrifugal blowers can achieve airflows of up to about 3,000 m³/h in start-up times of only 3-4 s. And they consume

Figure 2: Applications that require a rapid start-up of the fans used are e.g. air curtains for truck loading ramps.

Figure 3: At the heart of these fast starters, available in sizes 160-250, is a GreenTech EC motor.

much less power than AC fans do. Depending on the application, energy savings of well over 30% are possible with these centrifugal blowers. Despite their rapid start-up, they generate a low level of noise. They have a large number of forward-curved impeller blades, which is partly responsible for this property and ensures that the psychoacoustics are pleasant – especially in the low-frequency range.

Due to their high air performance (Figure 4), EC centrifugal blowers are also suitable for the high air curtains at large factory gates. Additional design details reinforce this effect. For example, the motor electronics are not attached directly to the motor, but instead to the outside of the scroll housing. This reduces the number of fittings that could obstruct the airflow. However, the electronics are cooled to the required extent: bumps on

Depending on the application, energy savings of well over 30% are possible.

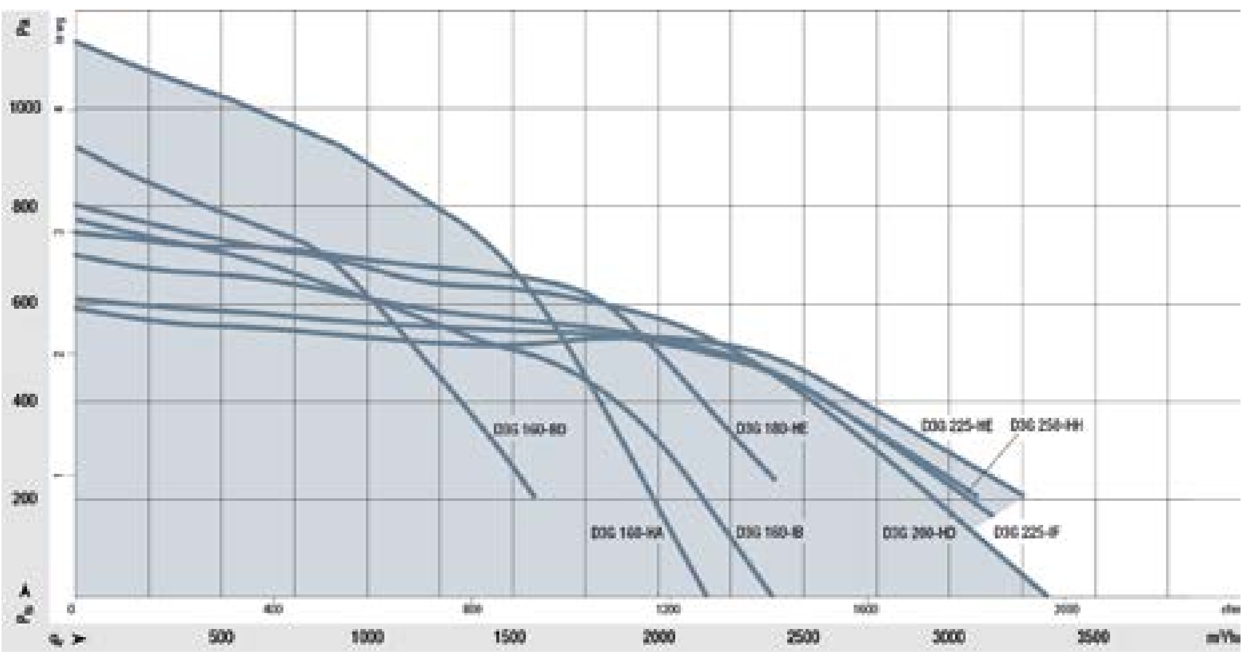

Figure 4: The EC centrifugal blower's air performance range goes up to 3,000 m³/h.

Figure 5: The bumps on the electronics housing (circled in red) improve cooling.

For maintenance, technicians are able to access the fans from a central computer.

the bottom of the electronics housing (Figure 5) increase the power density and reliably prevent overheating. The electronics are also reliably protected against outside influences such as moisture or dust. Their housing is made of rugged die-cast aluminum that satisfies the requirements for the IP54 degree of protection.

Parallel operation of several fans: active power factor correction Fans for air locks and air curtains are not "lone warriors" but instead are usually found in parallel connection. However, EC fans function in a way that has an impact on the grid. Operating several EC fans in parallel may cause the permissible limits stipulated in EN61000-3-2 to be exceeded and adversely affect other devices in the system network. Normally, operators must supply an interference suppression filter, ensure adequate power factor correction and be aware of the possible need for a larger cable cross-section.

The new EC centrifugal blowers eliminates the need for these precautions. Integrated active power factor correction (PFC) significantly reduces the harmonic content in input current (Figure 6). 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.

Regulation and monitoring as required Another feature of EC motors is their control characteristics: practice-oriented control options are a matter of course with these modern fans. The control electronics are perfectly harmonized with the motors they contain and they are also infinitely adjustable. This is possible over the entire speed range and even retains the fans' excel-

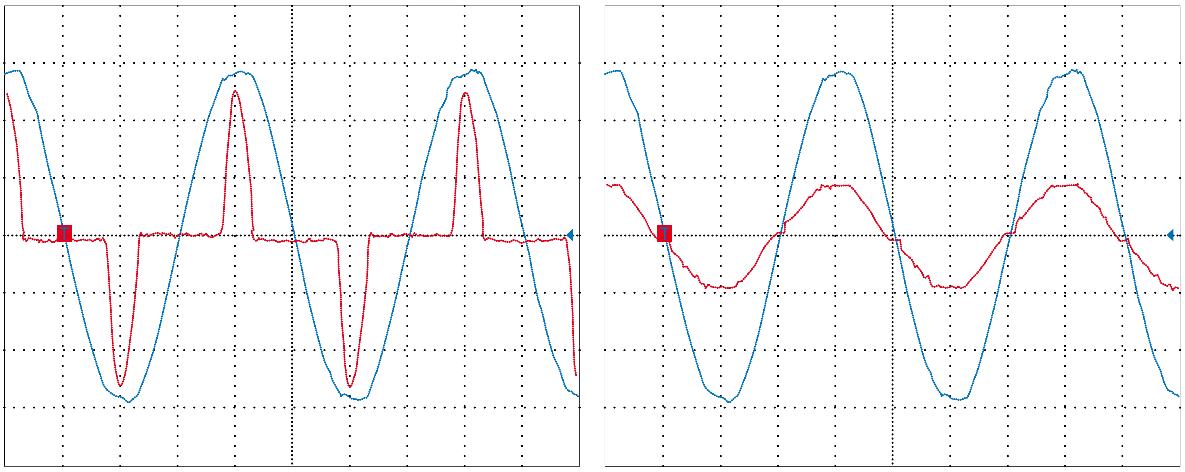

Figure 6: Integrated active power factor correction (PFC) significantly reduces the harmonic content in input current (left without; right with active PFC).

lent efficiency in partial-load operation. Via a digital RS-485 MODBUS-RTU interface, the units can be controlled as required. Especially when several fans are in use – as is the case with air curtains – bus connection offers advantages in a range of situations, from configuration during commissioning and troubleshooting to service and maintenance. For error diagnosis and maintenance, it becomes much easier to handle the technology when technicians are able to access the fans from a central computer. Other than the relevant computer software, there is also a PDA- and smartphone-capable version that can be used to parameterize, monitor and remotely control the fans in the network via Bluetooth interface without a cable connection.

Uncomplicated installation and commissioning A complete plug-and-play solution: The EC centrifugal blowers from ebm-papst can be put to work quickly and easily. The motor shaft can be positioned either horizontally or vertically, as required. All the components are designed to be highly robust and have long service lives. The blade and nozzle plate are made of galvanized sheet steel. A further argument in favor of these ErP-compliant, energy-saving centrifugal blowers cannot be overlooked: their development and production focuses on sustainability and resource preservation.

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Dynamic internal rotor for sophisticated applications

Efficient 750 W ECI drive based on customer requirements

In modern drive engineering, use is made of electronic control loops to attain maximum performance and reliability. But even the best control system is powerless without an effective actuator. This is where robust, electronically commutated internal rotor motors (ECI) come into their own. These highly dynamic drive units permit high-speed motion, allow short-term high overload and operate reliably over long periods even without maintenance. A new ECI motor with up to 750 W shaft output and a diameter of just 80 mm is now setting new standards in terms of power density, dynamics and versatility whilst offering standard mechanical interfaces for universal use.

Highly specialized one-off developments can achieve top performance, but at a considerable cost. With series components, which can be manufactured more cheaply in large quantities, it is however possible to obtain the same performance levels without high expenditure in the form of a versatile modular concept. Individual modules can be combined to produce drive units tailored to customer specifications. The specialist manufacturer ebm-papst were therefore quick to adopt the modular concept for their drive systems. By putting together individual assemblies to suit customer requirements, the company can offer a wide range of drive units “off the peg”. To

Figure 1: Highly dynamic with overload capacity and a long maintenance-free service life, the ECI 80 with 750 W output power.

be able to achieve higher power outputs, the new ECI 80 motor has now been added to the family of drive units alongside the existing ECI 42 and ECI 63 series (Figure 1) to extend the product range, particularly for applications requiring high power, highly dynamic performance and a low weight.

Opening up new perspectives... Modern robots, logistics, power generation, medical engineering and traditional sectors such as the woodworking industry all rely on efficient, highly compact and powerful drive units. There is an increasing demand for drive units which are even more powerful than the existing modular drives and also offer a compact design. In-depth analysis of the requests made by users revealed that a motor with a shaft output of 750 W would be an ideal addition to the modular range. Based on their experience with smaller drive units, the ebm-papst development engineers then worked out a concept for a highly dynamic 3-phase internal rotor motor featuring EC technology. A number of technical hurdles had to be overcome before these requirements could be satisfied in reality.

... and putting them into practice The main emphasis was on the highest possible power density, in other words low weight, high power and great efficiency. The development process was not made any easier by the somewhat conflicting aims of trying to achieve the lowest possible cogging torques and highly dynamic action at the same time. In-house calculation and simulation programs in conjunction with extensive testing finally produced the optimum result. The performance figures and low weight of today's ECI 80 exactly correspond to current and future requirements. It is thus the lightest motor in its class on the present-day market. A standardized system design which enables the motors to be manufactured on an automated production line with a very high level of process monitoring for all operations, the performance characteristics and system capability for a wide variety of potential applications all add up to a motor concept which is unrivaled in its class. For instance it is capable of both precise motion at low speeds almost like a stepper motor and of high-speed switching to dynamic operation. The motor is designed and constructed as an internal rotor synchronous machine with three-phase permanent magnet excitation and an eight-pole rotor rotating in a twelve-slot stator. With the robust stator winding there is little copper loss and the manufacturing costs can be optimized. The cogging torque can be reduced to a minimum by ideally adjusting the rotor plate contours. The complete absence of beveling in the stator and rotor is also highly advantageous from a manufacturing point of view. The bar-shaped permanent magnets made of neodymium-iron-boron are embedded in the laminated rotor core.

Performance in figures The three-phase brushless internal rotor motor is provided with quiet-running, robust ball bearings for maintenance-free operation. During the life expectancy of 20,000 hours, the drive shaft can withstand a radial and axial load of up to 28 kg at nominal speed. ebm-papst can supply the motors in versions for 24 and 48 VDC with a nominal speed of 4,000 rpm and a rated torque of up to 1,800 mNm at the motor shaft. The starting torque can be up to 5,600 mNm. With a shaft output of 750 W, the nominal current draw is below 20 A. The peak starting current of the drives with short-term high overload capacity is up to 100 A. The total weight of the most powerful motor with a length of 136 mm and a diameter of 80 mm is around 2.1 kg.

Adaptable drive solution for a wide range of applications The modular design means that the drive systems, comprising the motor, electronics, gearbox, brake etc. can be designed and configured to meet individual requirements. This allows optimum incorporation into many different applications. The standard areas of use for

With his performance figures the ECI 80 exactly corresponds to current and future requirements.

Figure 2: The compact drives with their exceptionally good power/weight ratio are also suitable for robots.

the powerful ECI 80 motors include automation with typical applications such as positioners for woodworking machines and intralogistics with driverless conveyor systems as well as shuttles and belt drives. The compact drives with their exceptionally good power/weight ratio are also employed in the field of robotics (Figure 2). Christleven explains: “The design of the motors makes them suitable for use in areas with special requirements such as medical engineering, where particularly high standards have to be met in terms of reliability and EMC protection. Examples include high-power operating table adjusters (Figure 3) to move every patient to the correct position, as well as mobile patient lifts for individual and ergonomical bedside care. Despite the amount of power involved, the high level of efficiency ensures long battery operating times.” The new energy-efficient top performers also make their contribution to the energy transition process. Adjusters such as trackers for solar panels (Figure 4) constantly guarantee an ideal setting with respect to the sun, whatever the weather and over the course of decades.

Figure 3: Reliability and EMC protection are essential in medical engineering, e.g. for high-power operating table adjusters.

Figure 4: Capturing more solar energy with adjusters such as trackers for solar panels is another talent of the robust, maintenance-free ECI 80 motor.

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Equipped to deal with the cold

Axial fans for high-performance evaporators

Axial fans in evaporators have a lot to contend with. The cold side of a cooling circuit is not exactly a technology-friendly working environment. The formation of ice and its removal, often involving the forceful use of tools, demands solutions which are robust but at the same time energy-efficient and which function reliably under tough ambient conditions. The fans also have to be able to withstand mandatory regular cleaning with a steam jet cleaner.

It was with precisely these requirements in mind that the motor and fan specialists from ebm-papst in Mulfingen set about developing their AxiCool product range. With these fans it is now possible to cover the entire spectrum of evaporators and air coolers used in trade and industry. Whereas sizes up to 450 are particularly suitable for commercial applications and small store rooms on sales premises, the new sizes 500, 630 and 800 are intended for larger-scale applications, for instance in large cold stores or warehouses and production facilities used in the food processing and foodstuffs industries. This means that practical and, what's more, highly

Figure 1: AxiCool fans as of size 500 are designed for use in large cold stores and production facilities in the foodstuffs industry.

The fan housing and blades are made of tough plastic which helps to counteract ice formation.

energy-efficient axial fans are now available for high-performance evaporators in industrial and commercial cooling systems (Figure 1).

Fans used in evaporators (Figure 2) can be described as follows: Every fan is a system comprising a motor, control electronics and a flow machine. This has to be considered in its entirety, particularly when judging energy efficiency, air performance and noise characteristics. The new AxiCool fans are based on just this philosophy. All the components are perfectly matched, right down to the peripheral parts such as the guard grille and patented fan housing system, the HyBlade® fan impeller, the motor and the control electronics. This adds up to a ready-to-install, energy-efficient, quiet-running plug & play unit. It also creates an ideal basis for better classification in the context of voluntary ErP labeling, which is increasingly becoming a standard feature of evaporators and air coolers.

Integrated diffuser for better air performance and lower noise level Consideration must always be given to the high back pressures involved when looking for ways to improve the energy efficiency of fans in evaporators. Bearing this in mind, the fans were fitted with a so-called diffuser in combination with guide vanes (Figure 3). This integrated guide vane system minimizes flow turbulence to achieve maximum efficiency and minimum noise. In this way, air performance can be increased by up to 12% and the noise level lowered by as much as 3 dB (A).

Optimization of defrosting cycles Further design details help to counteract ice formation and

Figure 2: Axial fans in evaporators have a lot to contend with. The cold side of a cooling circuit is not exactly a technology-friendly working environment.

Figure 3: The guide vanes in front of the guard grille minimize flow turbulence to achieve maximum efficiency and minimum noise.

optimize the defrosting cycles: For example, the fan housing and blades are made of tough plastic, a material which in itself is less prone to ice formation than metal. The metal guard grille is designed to withstand rough treatment. The need for this is obvious, given that mechanical means are usually employed to remove the ice forming on the grille. It is also flat rather than being curved to make it easier to clean.

In addition, a heating tape can be inserted directly in the fan housing system with the fan cover. The advantage of fitting the heating tape directly in the fan housing system is that the cavity acts like an insulator, thus preventing the unnecessary transfer of heat to the surrounding area. Heat is generated where it is needed. This reliably stops ice forming between the axial blade and the cover, which could block the fan. An air

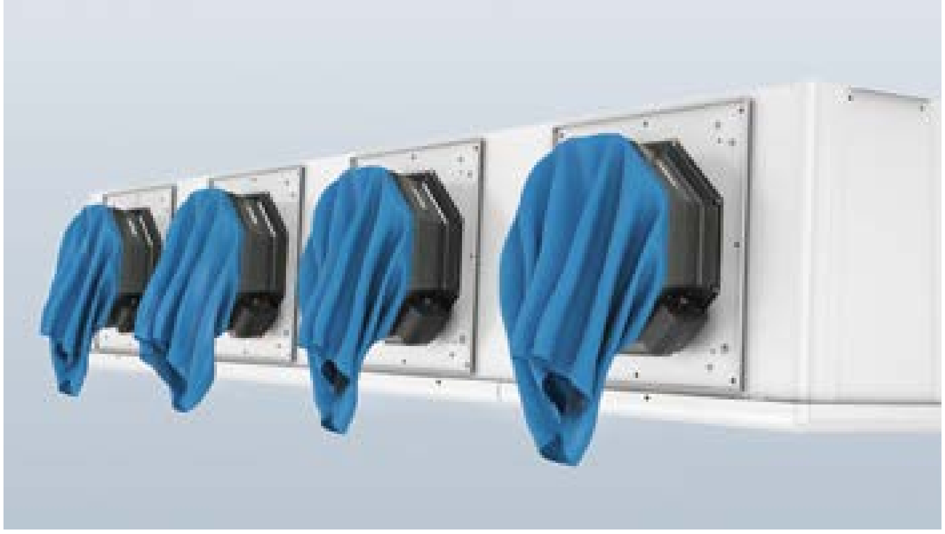

Figure 4: The fan housings are provided with an integrated mount for fitting an air bag which cuts defrosting cycle times by 50%.

The more stringent the hygiene requirements, the more important the fan housing cover becomes.

bag can easily be fitted to seal off the air discharge duct during defrosting and when the fan is switched off (Figure 4). An appropriate bead with a contact surface for securing is already integrated into the fan cover. The air bag causes heat to accumulate during the defrosting process and be retained in the cooler. This cuts the defrosting time by about 50% and makes for a low final defrosting temperature, thus saving a considerable amount of energy.

Drainage channels on the inside of the fan housing route the melt water occurring on routine defrosting towards the drip pan provided at the condenser. There is no danger of the blades freezing up or water being sprayed onto the items in storage when the fan starts running again. The more stringent the hygiene requirements, the more important this feature becomes. The contamination of open foodstuffs with splash water must always be avoided for example.

Standard and High-End versions of AC and EC fans With an air performance of up to 24,600 m³/h, the AxiCool series of axial fans is suitable for a variety of typical evaporator applications. All fans can be supplied as either a high-end version with integrated discharge vanes, fan housing cover and terminal box or as a standard version. This also has integrated discharge vanes; the terminal box and/or fan housing cover is/are optionally available with the high-end version. Where high hygiene standards are required, the extra advantage of the fan housing cover is that it is easy to remove the small amount of dirt likely to form on the smooth surface (Figure 5). It also reduces heat transfer to the cold store during the defrosting cycles.

Thanks to the special bearings and greases used, all versions can withstand temperatures down to -40 °C and, with their external rotor design, are extremely compact. This in turn means

Figure 5: AxiCool fans as of size 500 are available in two different versions: as a standard version including guide vanes and a fitting guide for the heating tape (left) and as a high-end version with additional fan housing cover to reduce heat transfer to the cold store (right).

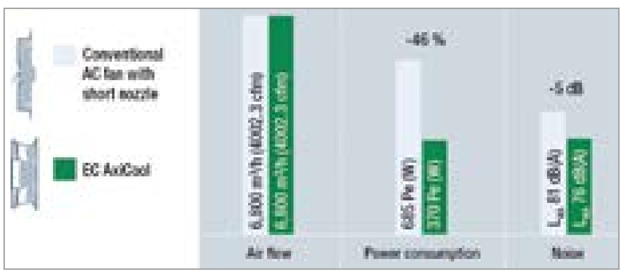

Figure 6: The EC version of the AxiCool reduces power consumption by 46% and sound emissions by 5 dB as compared to a standard AC fan with short nozzle (at the same operating point). Example of fan size 500.

that the entire evaporator unit requires less space. As standard, the fans satisfy the requirements of degree of protection IP55, can be used for either suction or blowing and are available in the same size with AC or energy-efficient GreenTech EC motors. Being far superior to AC motors in terms of efficiency, EC motors produce less waste heat, which is of course a great advantage for cooling applications. At the same time energy consumption is reduced. For a size 500 fan for example it is around 46% lower than with standard AC fans with short nozzle (Figure 6).

Control and networking: "IoT" (Internet of Things) and remote access As a further advantage, the EC version enables users to choose between conventional On/Off (two-step) control or demand-based control by way of a 0-10 V signal. 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. EC motors also retain their high efficiency level in part load operation. Demand-based control makes it possible to achieve further energy savings, for example the fan speed can be reduced when the shop doors are closed at night and the temperature tends to remain constant.

Using a serial MODBUS interface, the fans can simply be interconnected and incorporated into the higher-ranking building automation system for refrigeration circuit monitoring for instance. It is then also easier to access the refrigeration system by way of remote monitoring – a function which is certain to gain in significance in the future. The efficient, compact, tailor-made "Plug & Play" concept is sure to open up a wide range of potential industrial and commercial cooling applications for the "large" models in the AxiCool product range as well.

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Cool quietly with air

Improving the operating noise of fans

In many areas, current technology relies on targeted air cooling. In addition, modern DC axial fans score highly in many ways: they are energy efficient, durable, and do not require maintenance. Depending on the version, they can also be integrated into networks. Yet, one disadvantage of many fans is the unpleasant operating noise. With new fan concepts, noise emissions can be substantially reduced depending on the operating point; fans with low noise, which are also less bothersome, are particularly suitable for applications in areas in which people live and work.

Many applications require quiet fans with high flow rates. For example, if decentralized ventilation or a solar inverter is installed in a house,

Figure 1: In many areas, technology is advancing ever closer to people. In this regard, quiet-running fans can improve the well-being of the environment.

the living environment should not be negatively affected by excess noise (Figure 1). The same applies in automation technology, e.g., in frequency converters (Figure 2). For medical applications, a low noise level in the cooling of electronics is important in order to prevent additional disturbance to patients. In many applications – whether one considers refrigerated display cases in supermarkets, IT & telecommunications with switch cabinets, IT servers, or network equipment – technology is moving ever closer to people. Fans from ebm-papst, which cool the air without unnecessary noise, make a substantial contribution to making everyday technology quieter.

Causes of noise In general, fan noise can be caused by one of two mechanisms. The first is noise generated directly by air movement and the

Figure 2: The number of frequency converters is steadily increasing; quiet cooling improves working conditions.

associated pressure fluctuation (aeroacoustics). The second is noise resulting from the contact or rubbing of solid bodies (impact sound). In addition to these two main mechanisms, noise may arise from the integrated power and control electronics. When designing fans, aerodynamically generated noise poses a particular challenge. Even the smallest changes in blade design or in the struts or housing can have a considerable effect on the noise level. For example, the air flow on the outer and trailing edges of the blades can be interrupted, and the resulting turbulence increases the generation of noise. The air that flows over the struts, which keep the rotor in the housing, also creates turbulence. Pressure fluctuations also result when a blade sweeps over a strut.

Impact sound is the second component that contributes significantly to operating noise: for example, these vibrations of the fan structure may be generated by an imbalance of the rotor or an electric or magnetic impulse in the engine, which is similar to a familiar transformer hum. The structure then acts like a loudspeaker. The vibrations are particularly strong if the resonance frequencies in the fan structure are excited. However, beginning at a certain speed, the noise emission of the fan will be dominated by aeroacoustic effects.

Quiet operation can be developed To minimize these aeroacoustic effects, the rotating blades are fashioned in a complex manner. The aim of this process of aerodynamic optimization is to achieve low noise emissions with a high efficiency. One way in which this goal is achieved is by aligning blades and struts with each other (e.g., coordinating the geometries of the back edge of the blade and the front edge of the strut). Through continual improvements, fan specialist ebm-papst has obtained optimal results with its latest fan. This fan design was calculated with the help of specific simulation software and was verified in practice at our in-house testing station (Figure 3). Finely balanced rotors with maintenance-free ball bearings minimize vibration and reduce impact sound. Together with a vibration-optimized structure (designed with modern finite-element methods), the smallest possible impulse is achieved. The design engineers responded to the magnetic and electric excitation with optimized magnetic flux in the stator and rotor of the motor, as well as

Figure 3: The in-house testing laboratory and an air performance test rig facilitate the testing of new developments.

Figure 4: The new S-Panther: high performance and quiet operation.

An optimized current and magnetic flux ensure quiet operation.

with optimized electrical connections and select electronic components.

Measures in practice In order to minimize operating noise, the developer must implement a whole series of improvements. For example, let's take the new S-Panther model (Figure 4). An optimized current and magnetic flux as well as a precisely balanced rotor assembly ensure quiet operation. The aerodynamically designed outer edges of the rotor blades with so-called winglets, which are specially arranged struts (Figure 5), minimize turbulence between the blade and the housing. Together with the newly designed struts, the improvements enable the fan to work 3% more efficiently than its predecessor (Figure 6).

At ebm-papst, the modern design of fans involves the physical design, the specific drive concept, and control electronics, as well as the selection of materials and the construction of the fan itself. Thanks to injection-molding techniques, plastics allow for a wide variety of designs, that are lightweight, and (depending on the type of plastic used) offer great resistance against corrosion and wear. This is why the 3250J features select plastics that not only ensure a precise contour in injection molding but also provide a high degree of attenuation that is inherent in the material. The housing is made of glass-fiber-reinforced PBT (polybutylene terephthalate), and the impeller is made of glass-fiber-reinforced PA (polyamide). The drive motor is optimally integrated in the impeller, and the stator coils and electronics are also fully cast in plastic. This ensures good protection against water, dust, and salt spray, among other things.

Figure 5: Winglets on the blade tips reduce turbulence and thus noise levels.

Excellent combination of performance and reduced noise Although the technical effort involved in designing such a quiet but powerful fan is considerable, it does yield significant advantages in many areas. The 92 × 92 × 38 mm (H × W × D) S-Panther is available for 12, 24, and 48 VDC operating voltage, each with IP68 and IP54 protection (optional). Depending on the variant (7, 24, or 35 W power is available), the fan conveys between 145 and 270 m³/h with an operating noise of only 47 or 63 dB(A). The lifespan is over 85,000 hours (L10, 40 °C) according to the strict in-house test configuration and approximately 150,000 hours according to standard evaluations. Various optional features, such as speed signal output, a go/no-go alarm, or an internal/external temperature sensor are also available, as is PWM control input or analog input. The molded drive and specially sealed bearings provide protection against moisture and salt spray; the high efficiency results in lower electrical energy requirements. Those who value the highest possible air flow rate, and are willing to accept slightly increased noise, will be well served by fans of the S-Force series. Up to 280 m³/h at 73 dB(A) is possible! The pressure increase also improves from 340 up to 700 Pa. This ensures a high air flow rate even with greater air resistance in the unit (e.g., through filters or the compact arrangement of components).

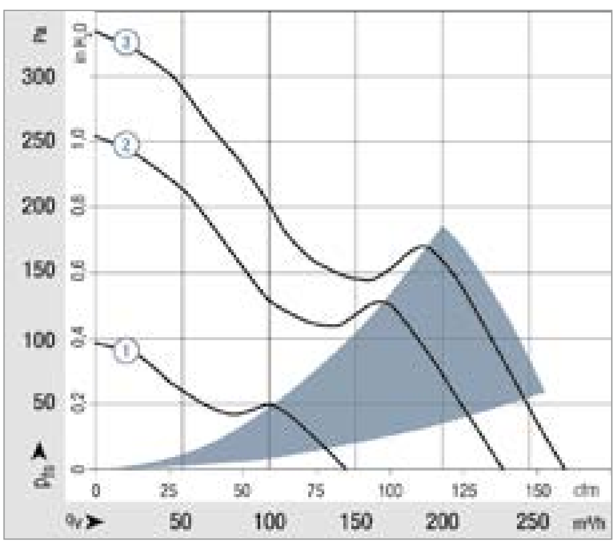

Figure 6: Performance chart of the new S-Panther.

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Correct FanGrid design

EC fans for efficient cooling in data centers

Mobile internet, cloud computing and ever more industrial networking have led to a massive increase in the volume of data being processed in data centers. Cooling is the key to efficient operation. Energy consumption is the main cost factor – and the cooling system is a crucial aspect. At present it accounts for around 37 per cent of the energy costs on average – and the figure is even higher with older systems.

Energy costs: the key to economical operation All efforts to cut operating costs therefore hinge on this item. Efficient cooling concepts these days are often based on free cooling and

ebm-papst FanScout helps customers to design the ideal FanGrid.

many do not require the use of compression refrigeration systems. Modern installations use the outside air, often in combination with adiabatic cooling (evaporative cooling), to provide appropriate air conditioning for data centers. Such cooling concepts do however require a large volume of air. Use is increasingly being made of so-called FanGrids – a system of centrifugal or axial fans operating in parallel – to satisfy the demand for a higher air performance (Figures 1a and 1b).

Air flow routing A distinction is made between indirect and direct free cooling systems. Indirect free cooling employs two separate cooling circuits. The cool outside air is not routed directly into the data center but is rather used to cool the circulating air flow in the data center by way of a heat exchanger. By contrast, a direct free cooling system draws in the cold outside air, filters it and routes it directly into the data center. Additional outside air filters are required with this method to ensure air quality and purity. The principle employed ultimately depends on the requirements, location and size of the data center concerned.

Customized FanGrids ebm-papst helps customers to design an ideal FanGrid with the support of the company’s Product Selector software FanScout (patent pending). The most economical system is worked out on the basis of parameters such as the installation space available, the required operating points and the desired level of redundancy. The software also takes the lifecycle costs into account, in other words the purchase price and operating costs over a defined period.

In the past, the operating point with the highest air flow (maximum operating point) often formed the basis for FanGrid design. This is however seldom attained – usually only if the data center is operating to full capacity with high outside temperatures in summer. Most of the time a data center cooling system runs at part load. For this reason the design software from ebm-papst allows up to five different operating statuses (operating points) to be specified. The applicable operating time in hours per year is stored for each of these operating statuses. This produces weighted operating points which reflect operation for the

Figure 1a: FanGrid made up of backward-curved RadiPac centrifugal fans.

Figure 1b: FanGrid with axial fans.

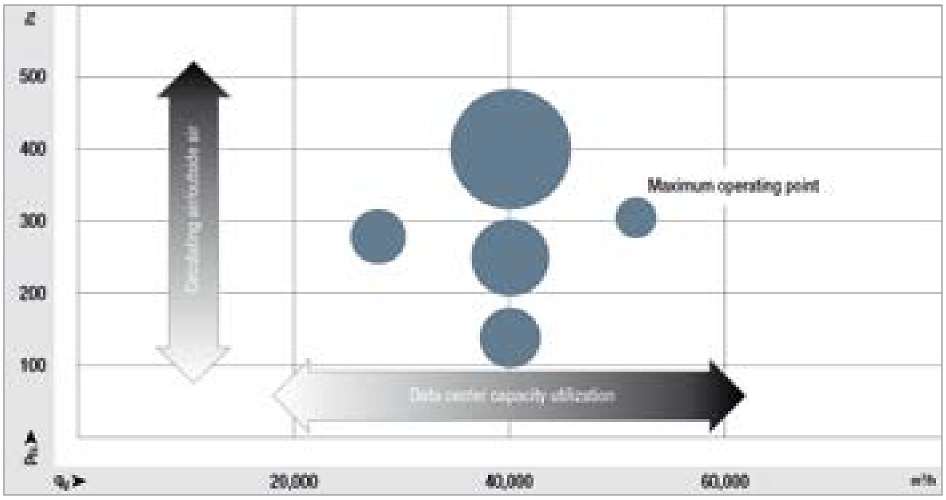

Figure 2: The blue dots symbolize various operating points. The size of the dot reflects the number of operating hours at this operating point.

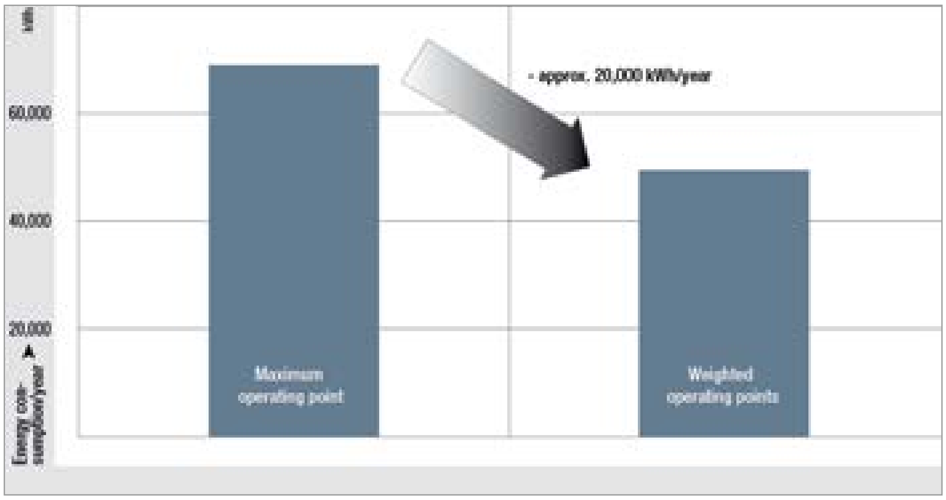

Figure 3: If the annual energy consumption of the FanGrid is calculated on the basis of weighted operating points as opposed to the maximum operating point, the real energy consumption will be 20,000 kWh lower, as shown by the calculation example for a FanGrid with four RadiPac centrifugal fans.

The fans are 13 per cent more efficient than their predecessors.

Figure 4: With the new RadiPac, particular attention was paid to the air intake in the impeller, the positioning of the external rotor motor in the impeller and the blade profile of the impellers.

year as a whole. An example is shown in Figure 2. Realistic figures for the expected operating costs can be calculated from these points. For this purpose, the software configures all the possible FanGrid combinations (type, size and number of fans) and works out the most energy-efficient alternative. When viewed over the course of the year it is quite possible that the combination with the greatest efficiency at the maximum operating point does not necessarily produce the best consumption figures on the basis of the weighted operating points.

The weighted operating points enable energy consumption to be calculated far more accurately. By way of example, Figure 3 shows the energy consumption calculation for a FanGrid with four RadiPac fans. The left bar represents energy consumption calculated on the basis of the maximum operating point (approx. 70,000 kWh). The right bar (approx. 50,000 kWh) shows the actual annual energy consumption of the FanGrid calculated using realistically weighted operating points.

All the latest technology Such savings can be achieved through the use of EC fans in FanGrids. These are highly efficient and can always be regulated to the required operating point. The new RadiPac EC centrifugal fan for ventilation technology has been on the market since October 2015 (Figure 4). These fans are not just 13 per cent more efficient than their predecessors, the noise level has also been cut by more than 3 dB (A). Optimized outflow characteristics ensure the best possible flow control even when there is not much room available (Figure 5, see page 34). The new RadiPac in FanGrids is thus the ideal space-saving solution for efficient operation in data centers.

Installation losses are another factor which tends to be overlooked in practice. If fans are installed too close together, they will influence one another. As a general rule, the greater the volume of air to be conveyed, the further apart the fans should be. ebm-papst's design software automatically allows for possible installation losses.

Fans work together FanGrids often feature built-in redundancy. If one fan fails, the speed of the others is automatically increased to provide the best possible compensation for the loss of air performance. This does however have the following consequence: On account of the fan failure, some of the air produces so-called backflow. The associated losses depend on the operating point and must be taken into account at the design stage.

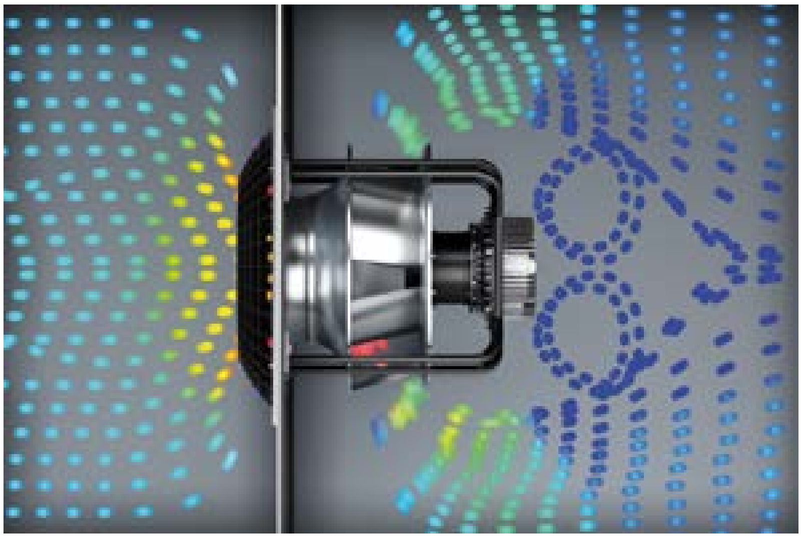

Figure 5: The new RadiPac EC centrifugal fan is not just 13 per cent more efficient than its predecessor, but also 3 dB (A) quieter. Optimized outflow characteristics ensure the best possible flow control even when there is not much room available.

To sum up ebm-papst starts by taking a look at the specific situation, including the installation space available, the operating points and the required level of redundancy, to ensure that the free cooling concept works with an optimum FanGrid design. Bearing in mind the lifecycle costs, the most appropriate system is then defined in terms of the type, size and number of fans to be used. Spacing and arrangement are further important factors when designing FanGrids. As a rule of thumb: The greater the air volume, the larger the space between the fans. Only then will the desired performance and efficiency be obtained. The Product Selector software FanScout permits the weighting of different operating points. Consequently the system design is not based on the maximum operating point as is often the case, but rather geared to individual customer requirements. In connection with the weighted operating points it is also possible to simulate various operating scenarios such as a constant air flow or constant pressure – making FanGrid design more efficient and cutting operating costs. Offering sophisticated EC technology and a wealth of expertise, ebm-papst can help customers find the optimum solution for their cooling concept. ○

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ebm-papst FanScout: Completely reliable and, above all, precise data as the software is based on true measured values. Not only is the performance of the individual fan components measured but also that of the fan as a complete system – as confirmed by TÜV SÜD.

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