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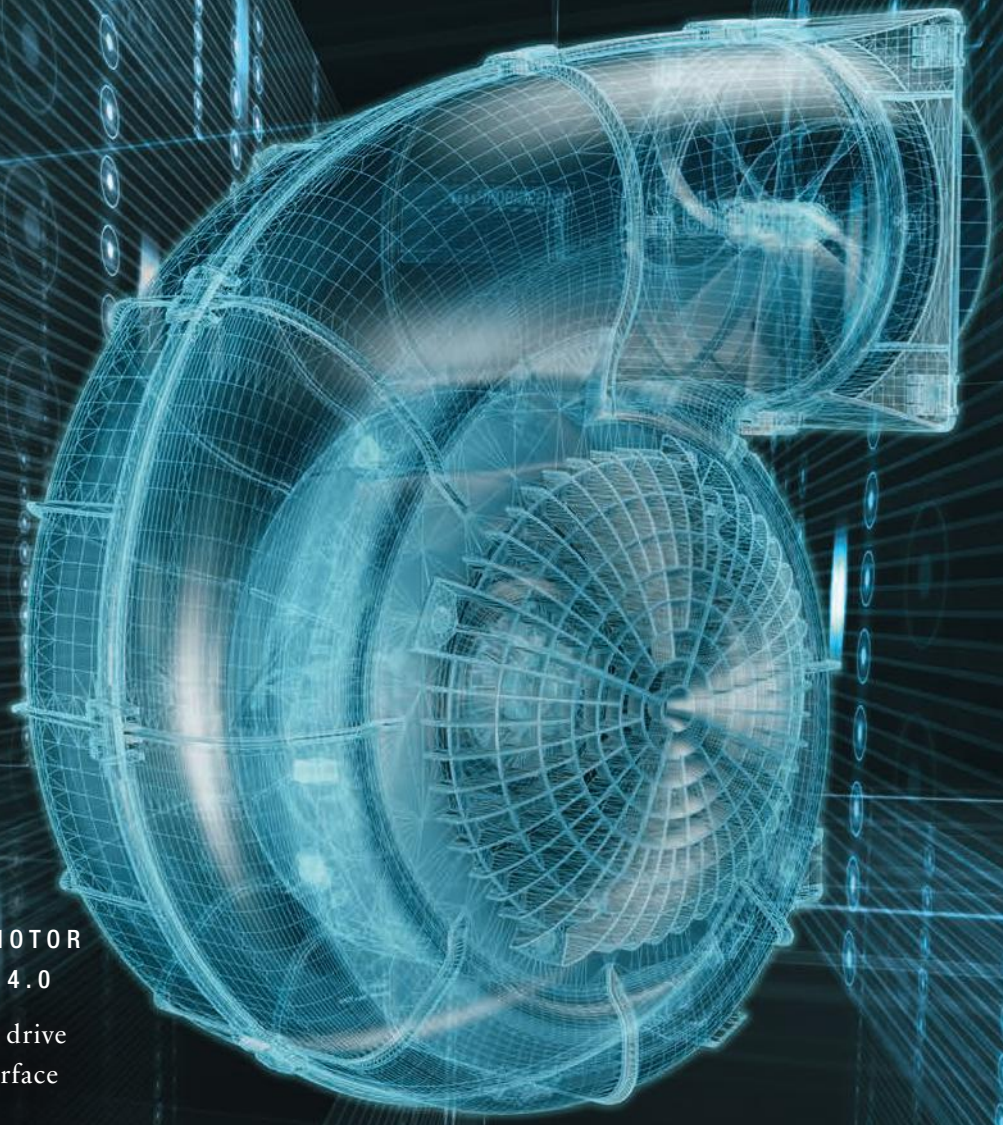
TechMag



BRUSHLESS DC MOTOR FOR INDUSTRY 4.0

Intelligent compact drive with CAN Bus Interface

DIAGONAL COMPACT MODULE

Smart electronics cooling for industrial applications

VERSATILE EC TECHNOLOGY

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"Ecodesign regulations are working"

Geoff Lockwood

TECHNICAL DIRECTOR
EBM-PAPST UK LTD
CHAIR OF THE FAN WORKING GROUP
EUROPEAN VENTILATION INDUSTRY ASSOCIATION

Dear Readers,

The European Commission state that 'By 2020, the first Ecodesign Regulations on 13 product groups are projected to allow energy savings equivalent to more than 12% of the electricity consumption of the EU in 2009 (compared to a 'business as usual' scenario)'. They are saying Ecodesign regulations work. They transform the market to more energy efficient products, they encourage innovation and investment, they create jobs, they instigate closer relationships between customer and supplier and they reduce our impact on the environment.

We see the effects of Ecodesign all around us with those regulations driving manufacturers to more energy efficient lighting, refrigerators, washing machines, dishwashers and televisions. Here at ebm-papst it is even closer to our heart, regulation 327/2011 setting minimum energy efficiency levels for fans has had a big impact on our business and aligns with one of our principles of energy efficiency and sustainability.

But this gain for the environment is being attacked by those that want business as usual. A key feature of regulation 327/2011 is that it 'includes those integrated in other energy-related products'. 90 % of ebm-papst fans that are within the scope of the regulation, and indeed those of most European fan manufacturers, are in the end integrated within other products.

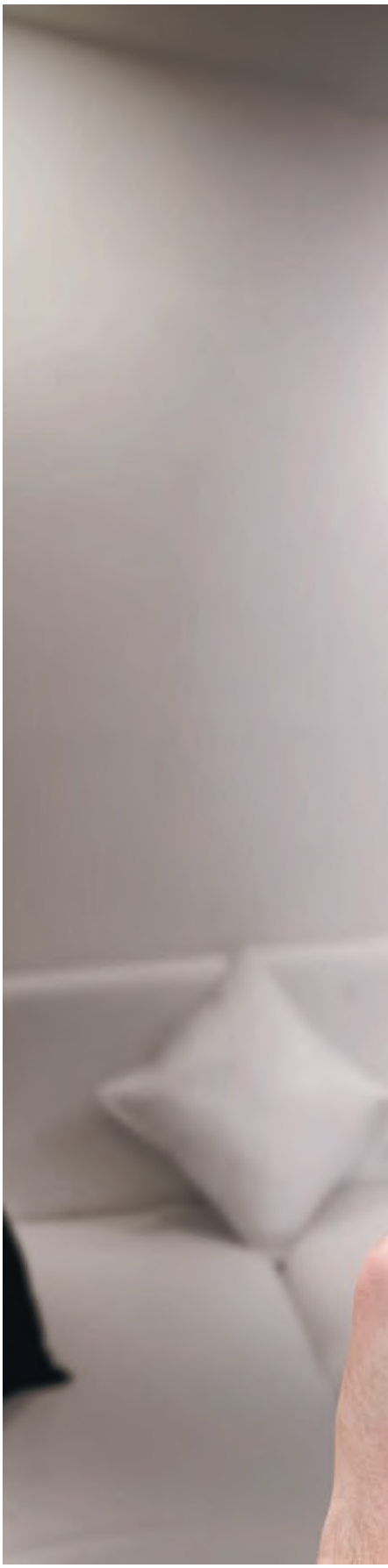
The business as usual community want to roll back the regulations 5 years. They want to exclude from the regulations fans integrated in other products. We at ebm-papst have a different view and believe we have a responsibility for our actions and to the environment and support the principle of the EU regulations. We actively engage in the Ecodesign process and support our industry through trade associations and standards committees.

Ecodesign has its challenges, but it works; it reduces energy consumption and our environmental impact. If you find Ecodesign is a challenge then talk to us and we will look for the right solution for you and the environment.

Have fun reading the latest issue of tech.mag!

Efficient and quiet centrifugal fans

Intelligent “heart” of home ventilation



When it comes to home ventilation, a distinction can be made between centralized systems, e. g. systems installed in the cellars or attics of houses or apartment buildings, and decentralized solutions for the ventilation of individual rooms. The latter are particularly suited for renovation of existing structures. However, both types require fans that can control air intake and exhaust. In the case of centralized ventilation units, the fans supply the air through various device components such as filters and heat exchangers, as well as through a branched channel system. For effective and efficient home ventilation, it must therefore be possible to precisely regulate the air flow in order to prevent overpressure and underpressure in the residential building. There are even more advantages for users if the fans are also able to process signals from external sensors.

Stanisic Vladimir, fotolia

When it comes to centralized units for home ventilation, the market trends towards backward-curved centrifugal fans. There is a good reason for this: The RadiCal centrifugal fans in the aerodynamically optimized scroll housing from ebm-papst have been specially developed for use in home ventilation units (Fig. 1). This achieves an energy efficiency improvement of more than 30% in comparison to forward-curved fans, which are still widely used in ventilation units. The improved energy efficiency is based on the combination of RadiCal fans with a scroll housing optimized for aerodynamics. The extremely efficient GreenTech EC motors also contribute towards energy efficiency. The round outlet of the new scroll housing fits directly onto the pipes that distribute the air. This reduces airflow losses in the pipe system. The noise level is also reduced by up to 3.5 dB(A) when compared to a centrifugal blower, as has been confirmed in numerous tests (Fig. 2). The disturbing tonal noise of a backward-curved impeller in a living environment has been significantly minimized through the combination with the optimized scroll housing. The tonal proportion in the disruptive frequency range is reduced by up to 20 dB in comparison to conventional installation

ebm-papst RadiCal fans with optimized scroll housing achieve an energy efficiency improvement of more than 30%.

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FIGURE 1: **RadiCal centrifugal fans in a scroll housing optimized for aerodynamics are available for use in central residential ventilation units, here with an additional FlowGrid air-inlet grille on the intake side.**

conditions. Furthermore, the fan can be mounted very easily in the ventilation unit via the discharge flange and even combined with the FlowGrid air-inlet grille, which can be mounted on the intake side. This reduces the turbulence caused by fittings in the unit, thus further minimizing the noise emissions.

Integrated volume constancy control

Due to physical factors, the volume flow control in backward-curved centrifugal fans is more costly than in forward-curved fans. However, ebm-papst has a ready-to-install plug & play solution for this: An impeller manometer positioned in the outlet of the scroll housing (Fig. 3) continuously records the actual air flow and transmits the data to the integrated central electronics system of the fan. This central electronics system adapts the speed of the EC motor to the desired setpoint value, thus regulating the air volume (Fig. 4, p. 8). Thanks to the impeller manometer (patent pending), the air flow can be regulated with an accuracy of +/-1% (to the end value) in an air performance range from 50 m^3/h to 500 m^3/h (Fig. 5, p. 8). This is significantly more accurate than the systems currently available on the market. In this application, a significant advantage of EC fans is that they retain their high efficiency and control accuracy even in partial-load operation.

The integrated volume constancy control enables effective home ventilation without an overpressure or underpressure occurring in the living space. This prevents humidity in the walls and unwanted cold air supply from outside. The additional impeller does not result in any air performance losses or disruptive noise, meaning that the overall performance of the fan remains unchanged. Even contamination is not a problem, as has been demonstrated in tests under extreme conditions with dust and increased air humidity.

Comprehensive sensor system and communication via MODBUS-RTU

The central electronics integrated in the blower offer even more options in addition to the motor control and volume flow control. Through the integration of a sensor in the blower outlet, it is possible to directly record the humidity and temperature of the supplied air. Furthermore, three additional external sensors can be optionally connected (Fig. 6, p. 9). There are two analog inputs and one digital input (I2C) available for this. Another 0-10 V input enables the connection of CO_2 or VOC sensors to record air quality, for example. With this wide range of options for recording

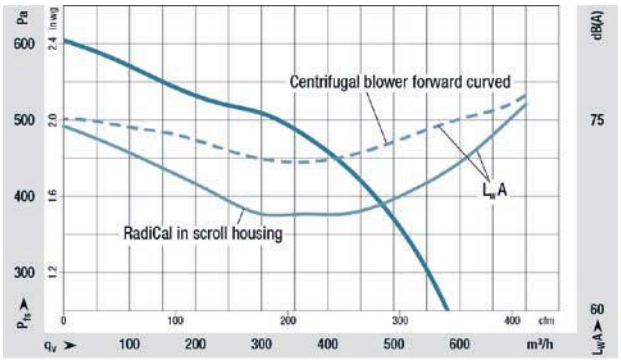

FIGURE 2: **The noise comparison shows that the RadiCal in the scroll housing (continuous line) is quieter than a centrifugal blower fan (broken line) by 3.5 dB(A).**

FIGURE 3: **Plug & Play – solution: The blower optimized for aerodynamics includes a control electronics system as well as sensors to detect the air volume, temperature, and humidity.**

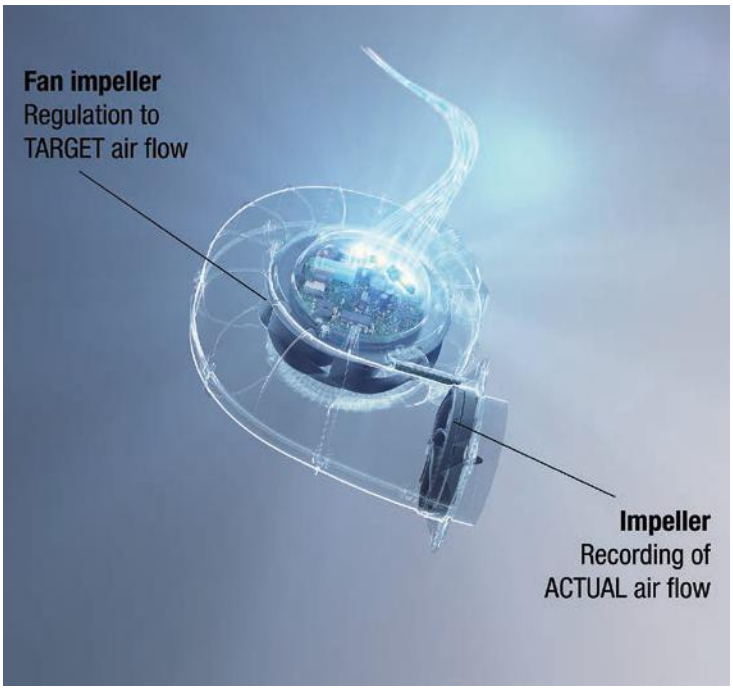

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FIGURE 4: **The central control electronics of the fan regulate the air volume depending on the ACTUAL air flow recorded using an impeller manometer positioned in the air flow.**

air quality, the ventilation in living spaces can be optimally controlled to provide a pleasant interior climate. Alongside the values detected by the sensors, it is also possible to record the operating data of the motor via the central fan electronics. This enables recording of the running time of the blower in order to determine when the filter needs to be changed, for example. All information can be communicated conveniently via the MODBUS-RTU interface. Alternatively, a 0-10 V interface is also available, which the user can use to control the fan speed as desired. The fan is the intelligent "heart" and central information source of the controlled residential ventilation system. It is therefore much more than just a fan that supplies air.

Perfectly equipped for the EU Ecodesign Directive

The RadiCal centrifugal fans in scroll housings are offered in size 190 with various output levels up to 170 W depending on the rated air performance of the ventilation units. The series is being expanded to include further sizes and versions.

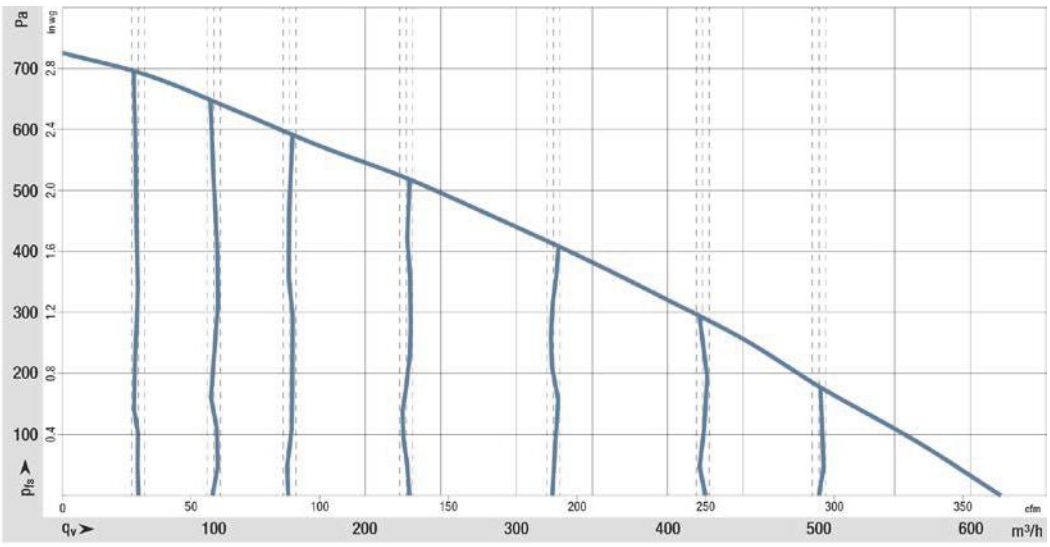

FIGURE 5: **Examples of volume constancy control stages. Thanks to the impeller manometer (patent pending), the air flow can be regulated with an accuracy of +/-1 percent (broken line) in an air performance range from 50 m³/h up to 500 m³/h.**

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In addition to the EC versions, an AC version without sensors is also available for applications that require less energy. However, in most cases it may make sense to use the energy-efficient EC technology that can be regulated as required. This is necessary if the intention is to achieve the highest possible energy rating label for the end device. Since January 2016, the EU Ecodesign Directive has stipulated that ventilation units with heat recovery must save as much primary energy as they consume, and must bear the corresponding energy label. The requirements in this regard are set to tighten further in 2018 and 2020.

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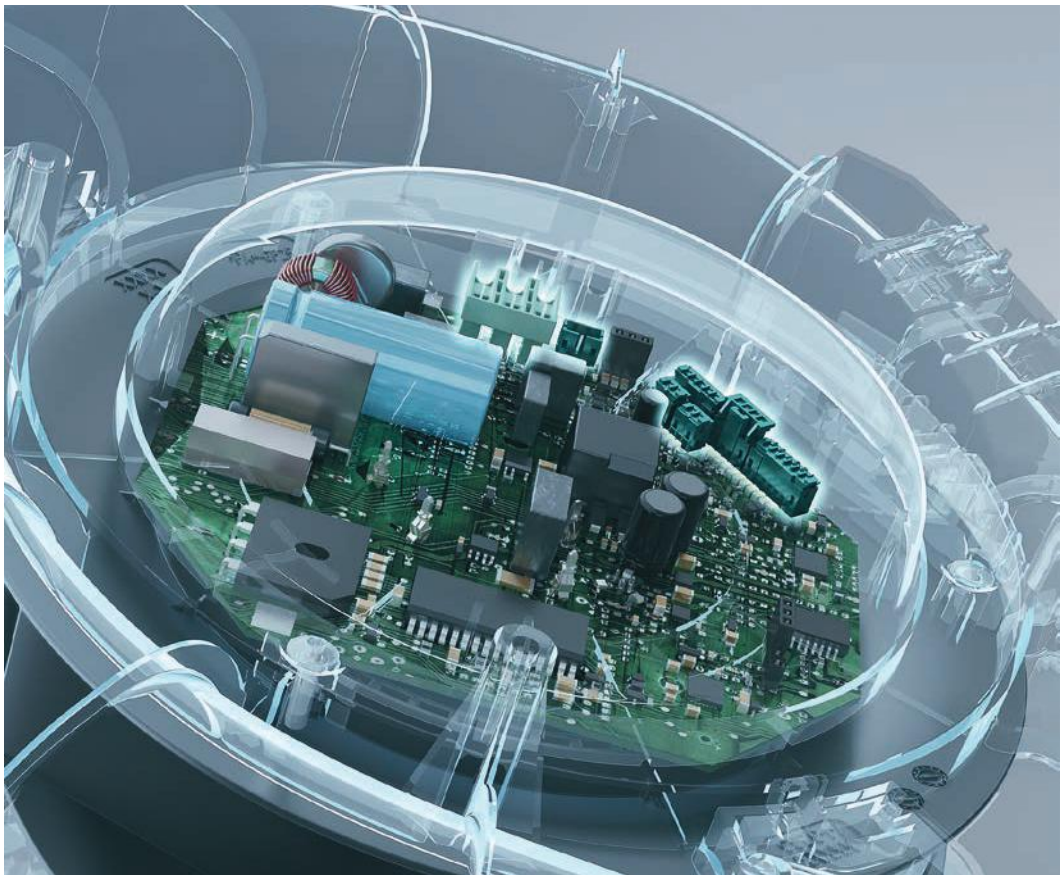

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FIGURE 6: **The central control electronics process the signals of the connected sensors, control the motor, and communicate all data via the MODBUS-RTU interface with the device control of the residential ventilation system.**

ebm-papst, fotolia

Brushless DC motor for Industry 4.0

Intelligent Compact Drive with CAN Bus Interface

Miniaturization and distributed intelligence are also current trends in mechanical and plant engineering. Accordingly, users are looking for compact, high-performance drive systems that receive commands from higher-level control systems via commercial bus interfaces and return actual values and status reports to the control system. In short, cost-optimized, Industry 4.0-compatible alternatives to classical AC servo motors are in demand. Our compact, brushless DC motor (BLDC) with integrated electronics module and CANopen interface provides a workable solution now.

Especially when many small drives in a system have to be coordinated, the usual division into servomotor and variable frequency drive saves neither space nor money. This is why ebm-papst expanded its ECI series of dynamic, industry-compatible BLDC internal rotor motors by the interconnectable ECI 63.xx K5 model (Fig. 1). With variants from 180 to 370 W, the compact drive covers a wide range of applications. In comparison to AC standard motors with variable frequency drives, it features higher efficiency and higher power density. The integrated electronics module provides many fixed and freely programmable functions. It not only relieves the higher-level control system, but can even replace it in some cases. Design complexity, installation and warehousing costs all fall.

ebm-papst expanded its ECI series of dynamic, industry-compatible BLDC internal rotor motors by the interconnectable ECI 63.xx K5 model.

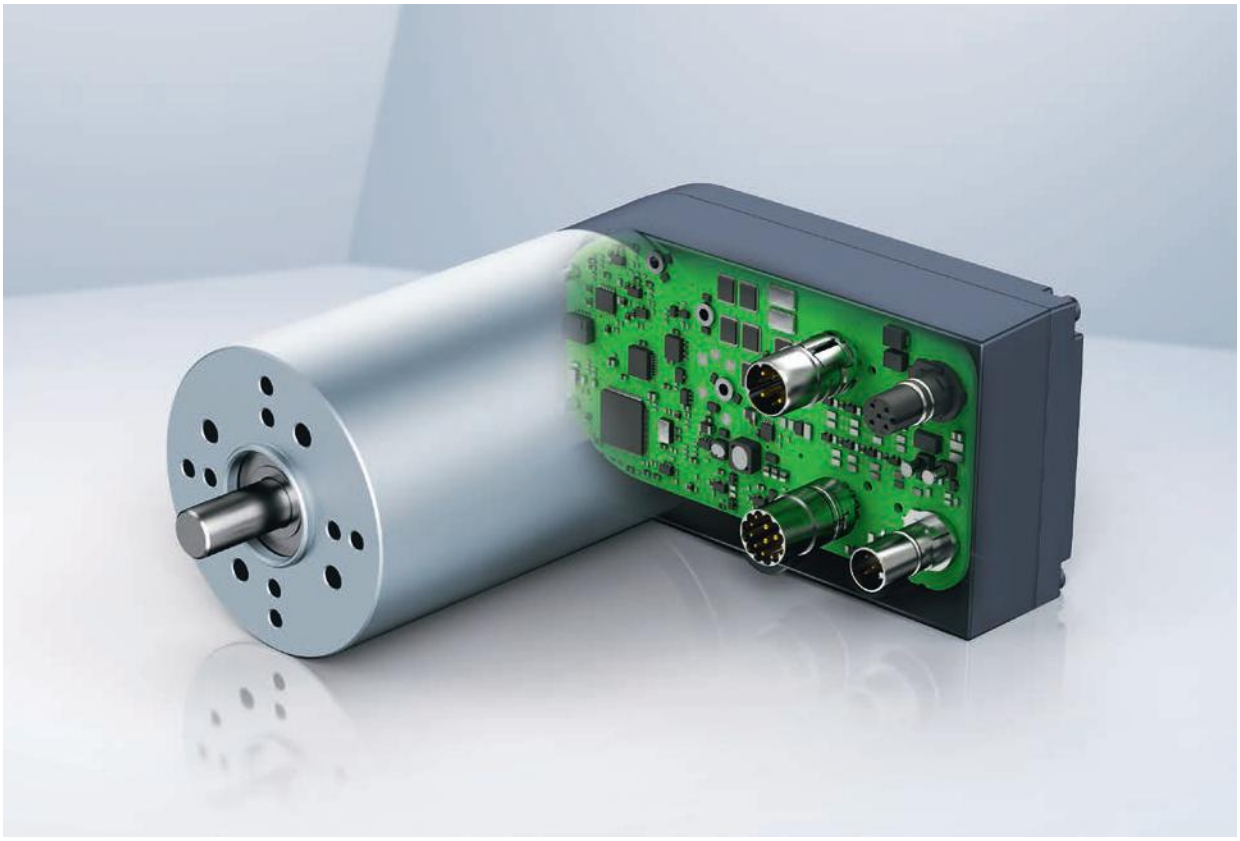

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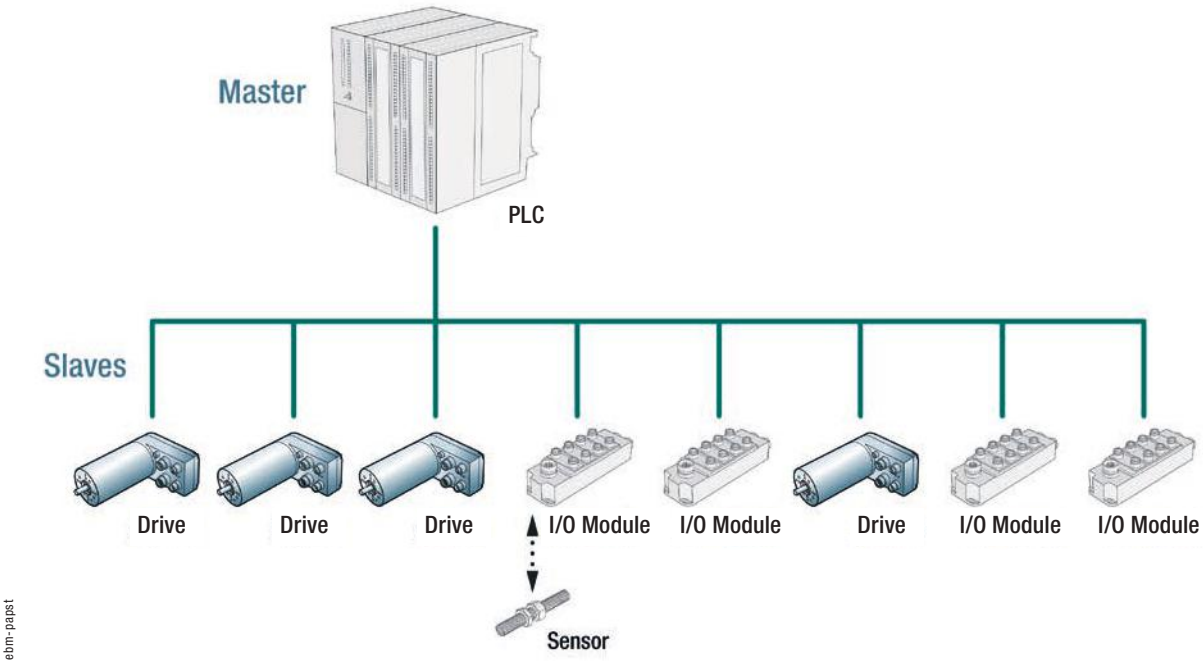
FIGURE 1: **The ECI63-BLDC internal rotor motor with an integrated electronics module provides a standardized CANopen interface.**

Before comparison



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After comparison

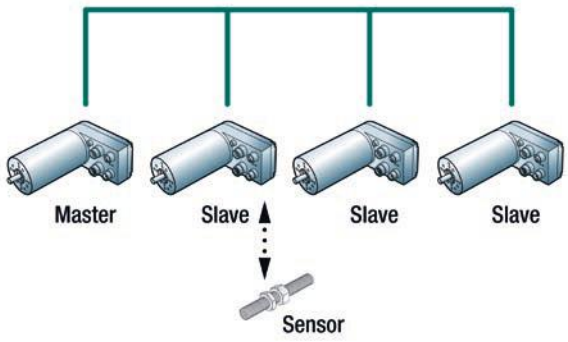

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FIGURE 2: **Before and after comparison: Thanks to integrated intelligence, the drive can be freely programmed like a PLC and therefore a higher-level PLC may not be necessary.**

The K5 electronics module is directly installed in the drive as integrated intelligence.

Intelligent drive takes over control tasks

The K5 electronics module is directly installed in the drive as integrated intelligence. This makes it freely programmable – like a PLC. Via integrated I/Os, it can virtually be activated as required; external navigation commands via bus connection are a thing of the past. And the drive can also be used as a CAN master. In this way, networks that work as standalone applications without a higher-level PLC can be established for less complex applications. This system reduces costs significantly (Fig. 2, p. 13). And an encoder system is integrated as standard to resolve the drive shaft positioning to 12 bit, achieving high positioning accuracy. Slow speeds and standstill can also be accurately controlled, making it possible to use a very wide speed range.
Because the drive supports communication and motion profiles as per IEC 61800-7 (DS402), it can be operated in positioning, speed, current or torque control. And interpolated positioning for cyclical set value requirements is also possible. Standardized homing methods and reduced-speed travel to mechanical stop (blockade) can be used to reference the drive position.

Communication via CANopen

Ethernet-based bus systems are required in many applications today, but as soon as the number of nodes in a system increases the proven CANopen bus is the solution of choice. The reason is that systems with CANopen offer clear cost advantages with regard to hardware and implementation. And CANopen's performance is ideal for many industrial applications; it eliminates the need for purchasing expensive communication equipment. A standardized CANopen communication interface available directly at the drive, the K5 electronics module can be used for drive-to-drive or drive-to-PLC communication as required.

Simple configuration

With epTools, the intuitive, free startup and parameterization software, the drive can be conveniently and directly configured from a computer via CANopen. The most important parameters are clearly visualized in the configuration window. Any number of additional parameters can be added to the GUI and uploaded to the drive. Plus, the entire parameter set can be saved on a computer. The status window displays a visualization of the relevant drive measurands and status information. This enables controllers to be optimized quickly and simplifies startup. Users can also operate the drive in various operating modes in the activation window and enable the controller and specify set values directly (Fig. 3). They can also set digital inputs and output in the window. Application-specific programs for integrated control are easy to compile in a different epTools window and upload to the drive.

The documentation for the new drive solutions, including technical data, drawings and 3-D models, is available for viewing on the ebm-papst online portal and can be printed or downloaded as required. ECI 63.xx K5 drives can also be configured online as solo and gear motors for a range of performance classes. All preferred items are ready to ship within 48 hours of order receipt. O

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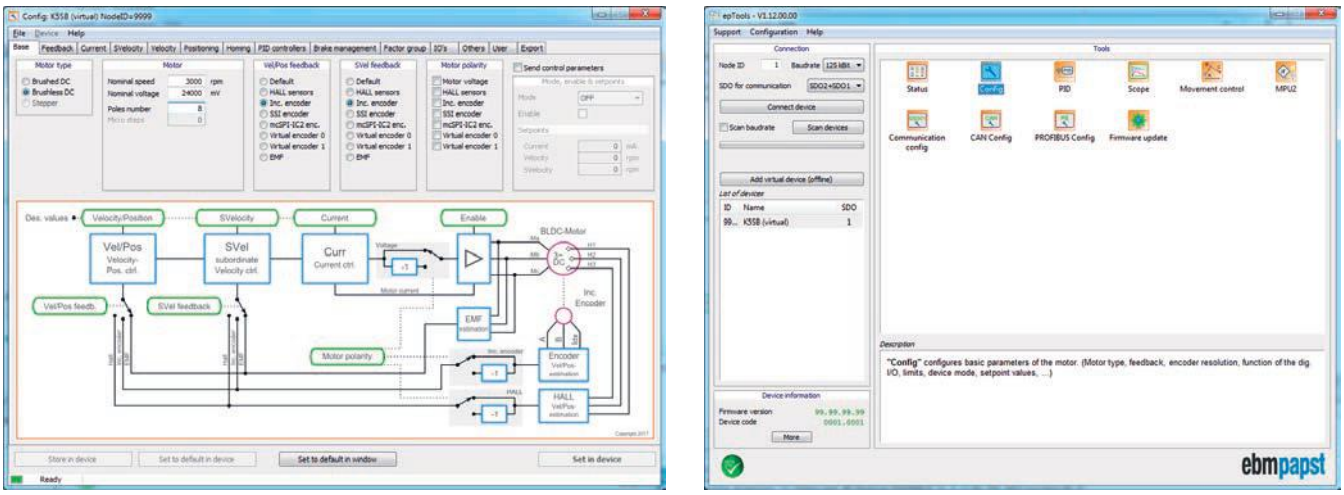

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FIGURE 3: **With epTools, the intuitive, free startup and parameterization software, the drive can be conveniently and directly configured via CANopen.**

industrieblick, fotolia

Diagonal compact module for filter fans

Smart electronics cooling for industrial applications

Electronics housings and control cabinets are often jam-packed; they need to accommodate more and more components. Their unavoidable waste heat results in hot spots that can easily reach temperatures of over 90 °C, causing heat stress that significantly reduces the performance and service life – and in extreme cases causes the destruction – of sensitive electronics. So-called filter fans, units that combine fans and dust filters, can help by conveying excess heat out of control cabinets and electronics housings while also preventing the ingress of dirt particles. Diagonal fans in compact modules are a breath of fresh air in many respects, with their flat design, high pressure stability, constant output and reduced noise levels.

To ensure that electronics function reliably, the waste heat resulting from their operation needs to be dissipated as efficiently as possible. This is usually done using a filter fan in the housing door to blow cold air into the interior. The air takes up the heat inside the housing, rises, and exits through an outlet grill or is extracted by an additional fan (Fig. 1). In practice, however, performance differences in the filter fans used are often observed. The axial fans that are often used frequently reach their limits, especially at high back pressures, which can be caused by high component density or increasingly fouled filter pads. The reason has to do with their operating principle.

When axial fans are no longer enough

Since the air flow in axial fans is parallel to the impeller's axis of rotation (hence "axial"), they can convey large amounts of air but only at low static pressure. This means they are best suited to free-blowing applications. Outside the correct operating range, i. e. at increasing pressure beyond the saddle point, the noise level of axial fans increases considerably because the flow stalls on the impeller and turbulence arises. At the same, the fan's efficiency decreases. A frequent reason for such a pressure increase is a dirty filter pad. As a result, centrifugal fans are usually the right choice when applications call for greater pressure stability. In this case, flow through the impeller is radial, i. e. perpendicular to the rotation axis. Since the entire flow exits the impeller at the outer edge where the higher rotational velocity is used to impart energy, the centrifugal fan produces a greater pressure increase. However, the amount of air conveyed is lower.

Motor and fan specialist ebm-papst has combined the advantages of these two different fan concepts in a new diagonal compact module (Fig. 2). The module is currently available in size 200 with identical dimensions, with the choice of drives using AC motors or the especially efficient GreenTech EC motors. Both versions are specially designed for use in filter fans. Other sizes are in the planning phase and will be implemented as demanded by the market.

Axial plus centrifugal makes diagonal

With axial inflow, the fan blades in diagonal fans move the air both axially and radially. The advantage of such a configuration is air flow that is largely similar to that of an axial fan but with a greater pressure increase. The curve is steeper and the saddle point is at a higher back pressure, which results in more constant air performance over a broad range when the fan is installed under operating conditions (Fig. 3). With back pressure, the adjustable modules equipped with GreenTech EC motors deliver up to 50% higher air flow than classic axial designs (for the same size and operating point), have lower noise emissions and consume up to 49% less power at the same air flow. Over time, this results in significantly lower energy costs for cooling control cabinets and housings (Fig. 4) while reducing CO_2 emissions.

Longer maintenance intervals for filter pads and quieter operation

As filters become increasingly clogged, the diagonal compact module supplies the air performance needed for heat dissipation. This considerably reduces power loss in the control cabinet, which in turn significantly enhances the cooling action. The diagonal compact module's pressure-insensitive curve lengthens both the service life of the filter pads and the maintenance intervals (Fig. 5). With the speed control for the EC motors via the 0-10 V interface, the air performance remains constant even with clogging; the cooling capacity adjusts to meet demand, and waste heat can always be dissipated in

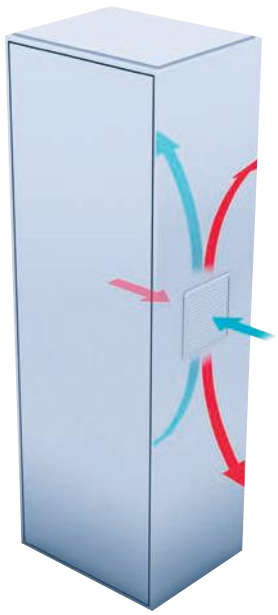

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FIGURE 1: **Electronics cooling with filter fans: The air blown into the housing takes up the heat inside, rises and exits through an outlet grill or is extracted by an additional fan (left).**

FIGURE 2: **The impeller in the diagonal compact module combines the positive features of an axial and a centrifugal fan (right).**

corresponding amounts so that the electronics are cooled reliably. The same applies when the intake temperature of the cooling air varies due to diurnal or seasonal effects.

The diagonal compact modules are also up to 7 dB quieter than conventional axial solutions – a clearly noticeable noise reduction, especially in situations where many control cabinets or electronics housings need cooling. At over 70%, the especially high efficiency of the EC motors also reduces the amount of waste heat generated by the fan itself; heat that is not generated does not have to be dissipated – a welcome effect for cooling applications in particular.

Simple conversion

But the diagonal compact modules have more to offer. They can be easily mounted on filter frames and are mechanically compatible with the industry standard, with external dimensions similar to those of the familiar axial design to facilitate easy replacement.

And they can be installed on either the intake or the outlet side, so those who install filter fans both ways need not stock multiple models. Plug connectors simplify electrical hookup, and the diagonal compact module can be installed in four different orientations 90° apart depending on the required plug position. Optional guard grills for outlet or intake side mounting round off the advantages offered by the diagonal compact module. The guard grills are aerodynamically optimized and can simply be snapped on without tools. Now an easily installed, practical and energy-efficient solution is available for filter fans to cool electronics housings and control cabinets. O

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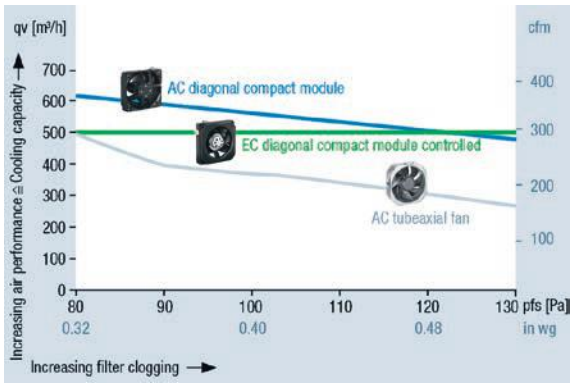

FIGURE 3: **Constant cooling capacity even as filter becomes clogged**

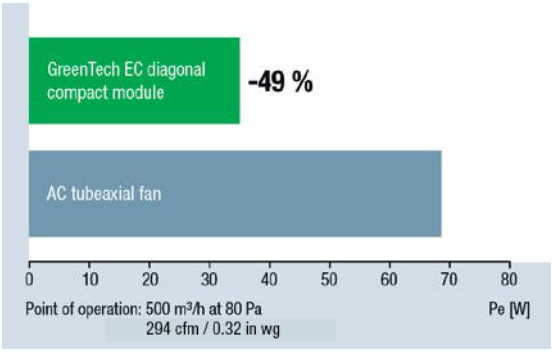

FIGURE 4: **Significantly lower energy consumption than an AC axial fan**

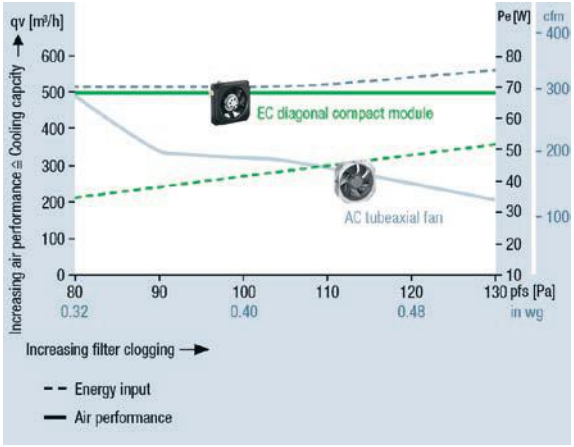

FIGURE 5: **The pressure-insensitive curve lengthens both the service life of the filter pads and the maintenance intervals.**

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Compact, energy-saving drives
not only for household appliances

Improving efficiency with EC motors

Rising electricity costs and stricter energy efficiency regulations are good reasons to shift automation and household appliances to the use of modern drives. Not only do the latest electronically commutated motors (EC motors) consume much less electricity, they are usually considerably more compact at equal or even higher power output. Their use in household appliances provides an example of the resulting benefits for machinery and equipment. So-called white goods now place demands on drive technology that are similar to those typically placed on small drives in industry. A few scenarios described below show the advantages EC technology has over conventional solutions.

JenkoAtaman, fotolia

When existing drives need to be replaced, the available attachment points often need to be taken into account. Drop-in replacement, i. e., simply exchanging motors when the relevant parts have identical dimensions, is then called for. It is quite all right for the shapes and dimensions of the motors to vary, but shaft diameter and length, vibration absorbers and hole diameters on mounting brackets should be identical. Since (built-in) household appliances are usually manufactured with standard dimensions, smaller drives mean more usable volume. They also facilitate the integration of parts for new convenience functions. In addition to these mechanical considerations, an increasing number of legal requirements now needs to be met. In both the EU and the US, in Canada and other countries, there is a host of laws, guidelines, directives and energy conservation standards imposing application-dependent minimum requirements on the energy efficiency of appliances. In the EU, the Ecodesign Directive 2009/125/EC provides the necessary framework for specifying requirements for the environmentally compatible design of energy-related products (ErP), including

ebm-papst uses flexible, electronically commutated DC motors even at low output levels.

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FIGURE 1: **Aerodynamically optimized: VHD 0146 standard blower with standardized outlet and contact protection integrated in the intake.**

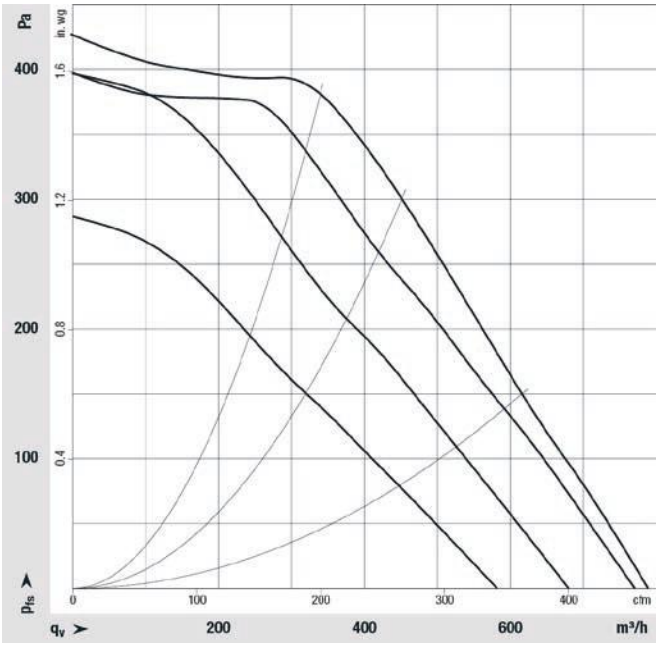

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FIGURE 2: **The VHD 0146 EC blower for range hoods covers typical air performance requirements in the range from 600 to 800 m³/h (free jet), replacing up to three AC blowers.**

the transparent presentation of the energy efficiency classes A^{+++} to G on energy labels affixed to appliances. Depending on the application, even small savings can be important in enabling a manufacturer to advertise higher efficiency with a better label.

And what does this mean in practice?

Simple motor designs such as shaded-pole or asynchronous motors are often no longer able to fulfill modern energy consumption and power density requirements. Motor and fan manufacturers such as ebm-papst Landshut therefore use flexible, electronically commutated DC motors even at low output levels. In contrast to conventional asynchronous shaded-pole motors, these small synchronous motors are highly efficient. In some cases, the commutation electronics even take over the functionality of a wide-range voltage input; such motors can be used without modification in almost all of the world's power networks, making adaptations due to differences in grid frequency (50 or 60 Hz) unnecessary. Thanks to their ingenious designs, these compact motors can be integrated into a number of applications.

Three example drive applications demonstrate the potential of EC motors: a compact motor for a dual-intake range hood blower; a drive for refrigerated display cases, refrigerators, freezers and refrigerator-freezers; and a centrifugal fan for drying applications.

Centrifugal fans for extraction systems

When large volumes of air need to be moved at medium to high pressure increases, dual-intake centrifugal fans are ideal. They are used in both household and technical applications, such as range hoods or soldering fume extractors.

In addition to improved energy efficiency, operating noise needs to be kept as low as possible. Range hood blowers such as the VHD 0146 are supplied as complete units comprising motor, impeller, and fan housing with corresponding aerodynamic optimization of the intake/outlet (Fig. 1 and 2).

With their compact form, EC motors leave more space for the aerodynamic design. In addition, their speed and air performance can be easily controlled with the commutation electronics, for example by pulse width modulation.

Depending on the motor model and fan series, additional features such as moisture or temperature sensors can be integrated for an automatic ventilation system.

Refrigeration applications

The air flow inside modern refrigerators and outside at the condenser is optimized by fans, which can be used to break up temperature stratification or, with directed circulation of cold air, to create fresh food zones or prevent condensation. Air flow routed through the condenser improves heat transfer; heat sinks can be more compact, increasing both the efficiency and the capacity of refrigerators. To make use of the efficiency of EC motors in existing appliances, the specialists in Landshut have developed the DE 20 motor specially for refrigerators and freezers. The motor's shaft length and diameter are the same as those of the shaded-pole motors previously used, so the spacing between the impeller and the heat exchanger (evaporator or condenser) can be maintained. The motor and the electronics are enclosed in a smooth housing, and the unit is connected as before with a two-wire cable. With a height of 40 mm, the housing dimensions correspond to the most commonly used standard size (Fig. 3). With electronic commutation, the motor speed is decoupled from the line frequency, so the fan's size and shape can be chosen according to purely aerodynamic considerations and its speed is adjustable. Fans with standard speeds of 2,200 or 2,500 rpm and a four-blade impeller with a diameter of 100 mm fit in many refrigerators as drop-in replacements. In this way, energy consumption can be reduced easily when modernizing product lines.

Time-saving and efficient laundry drying

Centrifugal fans are ideal when high air performance and a significant pressure increase are needed. They are used in applications such as clothes dryers and washer-dryers. Heat pump systems are often used in such appliances for efficiency reasons. They heat the air for drying the laundry in the drum. In a cycle, the heat pump extracts the heat

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FIGURE 3: **The DE 20 motor is specially optimized for refrigerators and freezers and is designed for standard speeds of 2,200 or 2,500 rpm in combination with a four-blade impeller with a diameter of 100 mm.**

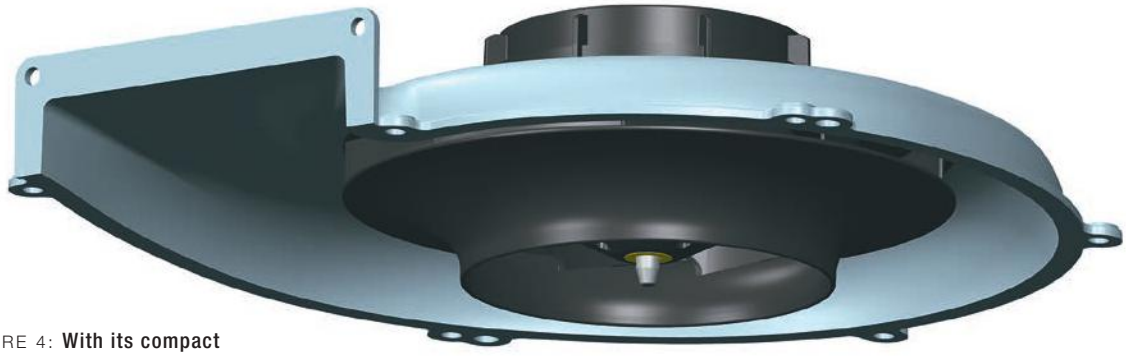

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FIGURE 4: **With its compact design, the R3G 150 centrifugal fan with EC drive delivers high air performance even where space is limited.**

and condenses the water from the warm, moist "exhaust air" and uses the recycled energy to reheat the now cold and dry "intake air." Only minimal heat losses need to be compensated, which reduces power consumption. However, additional components such as compressors, condensers and evaporators used in heat pumps need space. And the capacity of laundry drums has risen over the years from about 5 kg to as much as 15 kg. Both factors limit the space available for additional components since the standard outer dimensions of household appliances stay the same. A new, very compact centrifugal fan is the answer to this trend. With its compact design, the R3G 150 centrifugal fan with EC drive (Fig. 4) can deliver high air performance even where space is limited. Compared with previous AC solutions, it offers better performance in terms of both pressure increase and air flow. Higher air flow at higher pressure allows a more compact fan design. The higher motor speed enabled by the use of EC technology allows the use of a smaller, aerodynamically modified impeller. The miniaturized fan that results can fit in the smallest corner.

Increasing demands on motor energy efficiency and the trend toward ever smaller size at ever greater output are being met by developers with customized EC motors. Compact size, speeds independent of the line frequency, and exchangeable plug & play designs make the new drives the ideal choice for savings. Depending on application, operating mode and model, potential energy savings can be as high as 70%. This enables appliance manufacturers to quickly and easily modernize existing household appliance product lines, in the best case simply with drop-in replacement. ○

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Conversion to ErP-compliant EC fans

Extracting emissions – high performance for clean air

Every employee has a right to breathe clean air. That is also the case in the metalworking industry, where the cooling lubricants used for cutting and non-cutting machining are a source of aerosols, oil mist and vapors that pollute the air in production facilities (Fig. 1, p. 28), which is detrimental to the environment and can endanger the health of employees. As a result, statutory limits apply. To ensure that these limits are not exceeded, machine tools and machining centers are usually equipped with centralized or decentralized air purification units. As ErP-compliant drives for their fans, modern EC motors are well suited for a number of reasons.

Gina Sanders, fotolia

Air purification units generally make use of a multistage filtering and separation process. Fans ensure that the contaminated air extracted from metalworking machines passes through the various filter systems (Fig. 2), safely extracting emissions such as oil and emulsion mist and suspended particulate matter. This process calls for fans that generate relatively high pressure from a low air flow. The high pressure is needed to overcome the resistance from the filters. The fans should also be as easy to control as possible. The extraction flow can then be adjusted to the actual need, enabling energy-saving partial-load operation that also extends the service life of the filters. At the same time, the extraction performance can be kept constant in spite of increasingly clogged filters by appropriately adjusting the motor speed, and performance reserves can be made available for future system expansion as the speed and air performance can be adjusted as needed later.

Fans ensure that the contaminated air extracted from metalworking machines passes through the various filter systems.

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FIGURE 1: **Modern CNC cutting machines increase the amount of contaminants in the air in factory buildings; this can be remedied by air purifiers.**

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FIGURE 2: **Fans ensure that the contaminated air extracted from metalworking machines passes through the various filter systems.**

AC motors reach their limits

Until recently, AC motors with variable frequency drives had been considered suitable for operating fans. That has changed, since such motors often fail to comply with the current requirements of the European Union's Ecodesign (ErP) Directive. Now modern EC fans often present an ErP-compliant alternative in many cases (Fig. 3). An example is the innovative GreenTech EC technology developed by ebm-papst, which can play out all its strengths in air purifiers. EC motors are basically permanent-magnet synchronous motors in which a magnetic rotor synchronously follows an electronically generated rotating field. Their control electronics allow operation at any speed, even above the 3,000 rpm limit imposed on asynchronous motors by the line frequency.

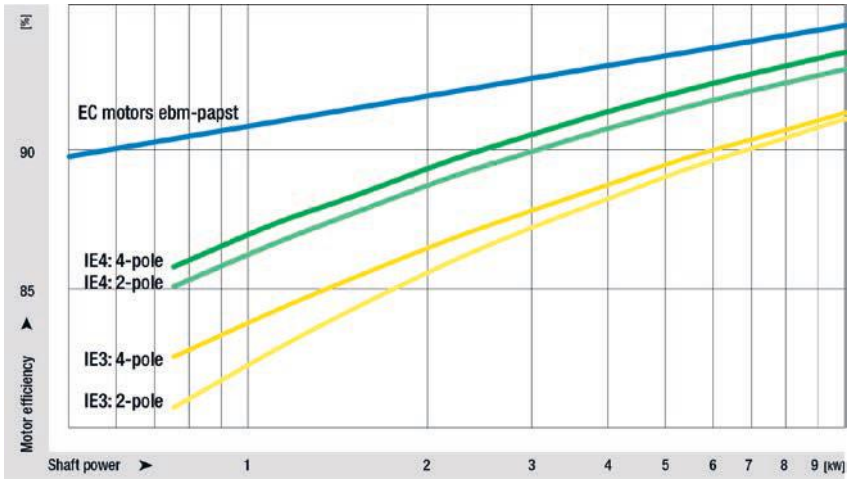

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FIGURE 3: **EC motors from ebm-papst significantly exceed the efficiency level called for by the ErP Directive.**

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FIGURE 4: **"Sifted air": Air-inlet guards reduce noise considerably by straightening out the air flow (left).**

FIGURE 5: **Compact and easy to install: EC fans for emissions extraction (right).**

The "Stealth fans" are ideal for applications in which noise protection regulations must be observed; in some cases, manufacturers can then use less insulation.

High efficiency, smooth operation and connectivity

EC fans work at much higher efficiency levels than asynchronous motors. Their optimized commutation allows partial-load operation down to 1:10 without a loss of efficiency, while their air flow can be adjusted as needed with a 0-10 V linear or PWM input. A PID controller is integrated in their motor electronics. Multiple fans can be conveniently networked via MODBUS and then controlled with a centrally connected air-monitoring system, and of course diagnostic and warning functions can also be used via the bus at the same time.

The high efficiency of the EC motors not only saves energy and lowers operating costs, but also generates less waste heat so that factory buildings are not additionally heated by the air purifiers during the summer. Commutation and the motor design also ensure very smooth operation. The high cycle frequencies are acoustically imperceptible, reducing noise emissions and making these "stealth fans" ideal for applications in which noise protection regulations must be observed; in some cases, manufacturers can then use less insulation.

But it is also possible to go a step further. Moving air is always accompanied by a certain amount of noise. If the EC fans are now combined with air-inlet guards (Fig. 4) on the intake side, a drastic reduction in noise emission results and turbulence and annoying low-frequency sounds are minimized. This reduces the frictions that can otherwise arise when people and machines share the same space.

Easy installation and commissioning

The fans from ebm-papst with backward-curved, aerodynamically optimized aluminum impellers for use in air purifiers are available in sizes 250 and 310 (Fig. 5). They cover a range of drive powers between 250 watts and 12 kW. Flexible options for installation include short delivery times and mounting with vertical or horizontal motor shaft orientation. With their compact dimensions, they are also suitable for retrofits, as when energy-saving replacements are called for or increased air performance is needed in a limited space. Such retrofits usually require minimal adaptations, if any.

Since the electronics and motors in the EC fans are combined in a single unit, installation is simplified and requires less space. Since the motor and the electronics in the motor system are already perfectly matched, there is no need for additional electronic filters and shielded cables. Nor is an external motor protection switch required. Costly adaptations during commissioning in the air purification units can be dispensed with, as can grounding and shielding. All these characteristics make the energy-efficient and ErP-compliant EC fans a worthwhile alternative for centralized or decentralized air purification units. ○

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