tech.mag

01/2006

NEW IDEAS AT A GLANCE

ebmpapst

Editorial

„ebm-papst – Our head start in technology has always been and still is the secret of our success!“

Dear customers, partners and friends of ebm-papst,

Normally, only the artists get to stand in the limelight. But the engineer's art is equal to the performing arts. If not superior. Engineers are the true avand-gardists, are the motors propelling the world forward and making progress possible.

Innovative engineers are also the cornerstones of ebm-papst. Our head start in technology has always been and still is the secret of our success. For more than 40 years, we have managed time and again to develop and design products with a claim to top quality and perfect design. Our EC motors and EC fans are great energy savers, less noisy and more technologically progressive than the products offered by our competitors.

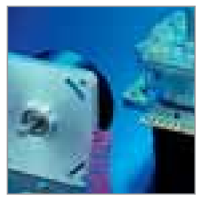
Offering a new and demanding product range is the only way we and the entire German industry are going to stand a chance of making Germany stay an industrial nation at which production takes place. In order to ensure this, we not only need a great number of skilled workers, we also need good engineers – both in R & D and in sales and production – and we need basic research at university with a strong focus on the demands of our industry. There is no way we can withstand competition from cheap production countries like China in the long run if we only rely on mass production and high quantities.

ebm-papst is and will remain a company with a technological drive. This is to say that we have always recognised and utilised the economic perspectives of a new technological development – despite all the risks involved. This is one of the most important factors of our success, and we shall keep it that way in future, too. However, we have to also make use of the entire global market, as we have reached a certain size, too. One of the consequences is certainly that we will be obliged to produce close to where we want to sell.

The fact that we can make end customers, such as supermarket operators, aware of the economic and technological advantages and benefits of our EC technology plays a more and more important role for our company. This way we also support you as our customers in going new ways and taking advantage of the opportunities offered by this new technology. This issue of tech.mag. focuses on this, too, and so I hope you find this latest issue full of interesting aspects helping you in your particular field of work.

Gerhard Sturm
Managing Director & Partner
ebm-papst

Table of content



Energy-saving fans in Fan Coil Units

Rising energy costs and new regulations have led to a holistic way of looking at energy consumption in buildings. When selecting units and components, more and more consideration is given to energy efficiency, and life cycle cost (LCC) has now become a main aspect in any decision making process. For manufacturers of components, this has been a minor revolution. No longer is it the cheapest component customers demand (almost always coming from China anyway), it is the most cost-effective variant that gets selected for use. There is now a call for a marketable cost/performance ratio, which is mainly determined by primary costs, operating and service & maintenance costs. Unfortunately, though, the operators of the buildings under construction, i.e. the ones having to pay for the operating costs, are often not included in the decision making process at all.

Fig. 1: ebm-papst D4E146 with plastic housing

Fan Coil Units (FCU) are part of a central air-conditioning unit tasked with either cooling or warming the air via circulation process. These units are commonly found in offices, hotel rooms, and the like and are therefore always close to people, which means that specifications as to comfort are tough and high. One of the most important criteria is thus minimal noise across the entire operating range. Today, this can be accomplished by using intelligently spaced and aerodynamically optimised fans. Apart from the noise caused by the air, the noise generated by the motor itself plays an important role, especially at lower speed, i.e. with low airflow. This is why it is so vital to optimise this component. One can either optimise the motor-housing decoupling, or , better still, one can use high-quality motor designs that do not generate vibrations to start with, thus avoiding an excitation of the environment. Motors with such characteristics are, for instance, the so-called EC-motors (EC for “electronically commutated”). In addition, fan housings made of plastic absorb vibrations excellently and thus contribute to reducing the emission of noise. Fig. 2 shows how AC and EC fans compare at the lowest - and thus most critical - speed steps.

Such EC-motors offer even further and more important advantages over motors in asynchronous design (AC-motors): they have a substantially higher efficiency. In other words, they use energy a lot more effectively than comparable motors in AC technology – and this at identical air performances. The following list shows a comparison between EC and AC fans at identical operating point.

„EC fans are easy to put into operation: simply ‘plug and play’!“

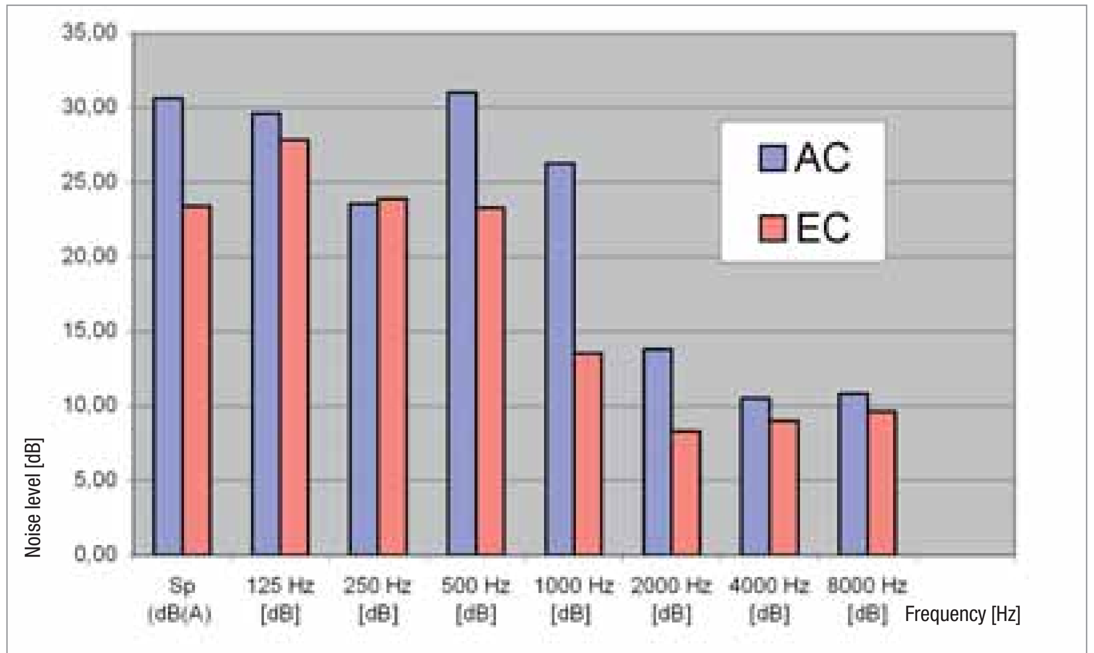


Fig. 2: Acoustic comparison between ebm-papst AC fan (blue) and EC fan (red) in the lowest speed step

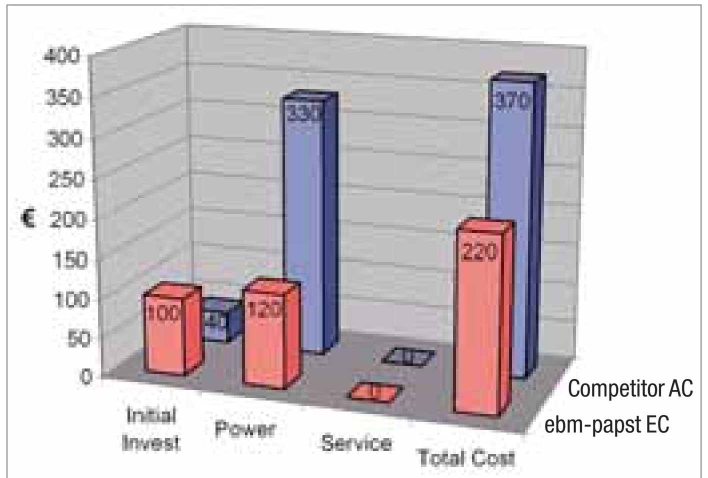


Fig. 3: Total costs during the observation period (10a)

The figures given are based on the following parameters:

- Energy costs 0.1€/kWh
- Operating time 3000h/a
- Observation period 10a
- Service costs are not taken into account

It is easy to calculate the amortisation period for the fans with more efficient drives, then. The graphic below shows the overall operating costs (cumulated) of a fan inside an FCU. The point where both lines intersect denotes the point as of which the more expensive solution gets amortised.

Cost savings due to efficient components: Energy-saving fans in Fan Coil Units

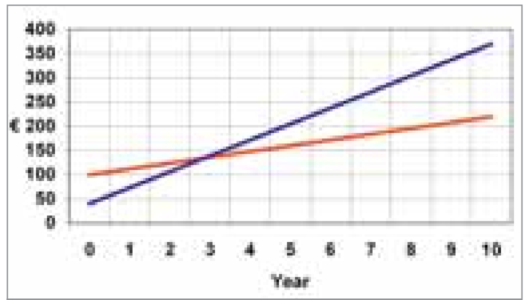


Fig. 4: Cost development, cumulated – “Pay off period”. AC fan (blue) vs. EC fan (red)

Apart from the advantages we have looked at so far and which can be measured (acoustic behaviour and energy efficiency), there are other benefits EC as higher-quality technology offers. Take for instance, the features and functions. The motor has a 0-10V/PWM input to continuously control the motor speed, a TACH output that can be used to control functions, and a 10V voltage output to connect a potentiometer.

Additionally, the EC solution as discussed here is absolutely easy to install: “Plug-and-Play“ is guaranteed!

MBA, Dipl-Ing. (FH) Uwe Sigloch
Head of Project Management Sales & Distribution
ebm-papst Mulfingen GmbH & Co. KG

New test facility for combined air and noise measuring of fans and blowers put into operation

Abstract:
At the beginning of 2006, ebm-papst in Mulfingen started up their new test facility for collecting aerodynamic characteristics and measuring the noise emission of fans and blowers in compliance with all the relevant standards and regulations. (Fig. 1 shows the plan view of the test facility with the main components). In order to measure air volumes of up to 100,000m³/h at pressures of up to 3,000Pa as well as noise as of 30dB(A) simultaneously, it was necessary to rest the test facility, made up of two chambers and weighing 600t, on anti-vibration mounts (fig. 2). On top of this, all components of the test facility – such as auxiliary blowers, air flow measuring nozzles and choking devices – had to be encased in a pressure-tight steel mantle and then de-coupled from the test chamber in terms of vibration and acoustics. The first part of this contribution explains the basic concept of simultaneously measuring air performance and noise. The second part then presents the results of the validation measuring carried out at the end of 2005.

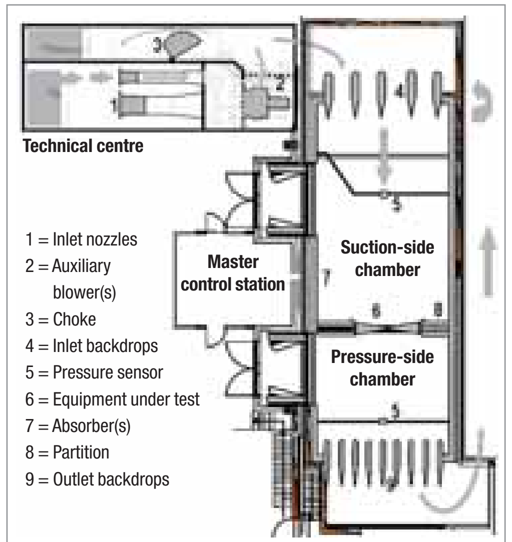


Fig. 1: Plan view of the test facility

1. Specification and functional design
Nowadays, when developing fan impellers, CFD programmes are used to calculate the flow of air through the fan. This computational advance optimisation makes for a significant reduction in development times. However, measuring is still a vital part of the development process. Not only to validate the calculated results, but also because the aerodynamic performance of a fan inside a customer unit can only be simulated at great expense, and the acoustic performance of a fan inside a customer unit absolutely refuses to be simulated.

As the existing test facilities at ebm-papst Mulfingen were not suitable to accommodate the new and bigger axial fans, planning a new test facility started two years ago in close cooperation with the Fraunhofer Institute for Building Physics in Stuttgart. Other than with conventional approaches, the new test facility was specifically designed to allow for the simultaneous measuring of air performances of up to 100,000m³/h at 3000Pa as well as sound performances as of 30dB, complying with the specifications of the relevant standards and regulations ([2], [3], [4], [5], etc.).


Equipment under test mounted in partition wall

World premier at ebm-papst: New test facility for combined air and noise measuring of fans and blowers put into operation

„Combined airflow and noise measuring optimises design and development cycles substantially."

In order to comply with all standard specifications, the test facility is made up of two lowreverberation noise-measuring chambers separated by a wall in which the equipment under test is mounted. The walls and ceilings of these two chambers were panelled with broadband compact absorbers (BCA) and comply with accuracy class 1 according to DIN EN ISO 3745 [1]. The air flow for setting the desired operating point is generated or controlled down in the upstream technical centre, and so, in aerodynamic terms, the test facility qualifies as suction side chamber test station according to DIN 24163 T2 [2] respectively ISO 5801 [3].

At the core of the technical centre, there are two speed-controlled auxiliary blowers to increase air flow (fig. 3), the larger one with a drive capacity of 75kW and an impeller diameter of 160cm, and there is also the choke weighing 40kg. 7 high-precision inlet nozzles are used to measure air flow and sucking in the required air. The largest of these inlet nozzles has an internal diameter of 1m.

The air is then conducted into the suction-side test chamber via big channels. Several backdrop sound suppressors connected in series prevent noise getting from the technical centre into the test chamber. For

Fig. 2: The test chamber weighing 600 tons is anti-vibration mounted and rests on ca. 40 steel springs.

acoustic reasons, the entire technical centre is housed in a 4mm thick, airtight steel sheet shell and rests on floating supports. To make sure there can be no potentially interfering impact on the 30m long, 7m wide, and 5m high test facility, it is decoupled from the rest of the building and the technical centre as well. For this reason, the concrete body weighing 600t is anti-vibration mounted and rests on 40 steel springs. To prevent any sound from getting into the

Fig. 3: The impeller of the larger auxiliary blower is 160 in diameter.

test chamber against the direction of the air flow, the air leaves the pressure-side test chamber via outlet backdrops and flows back into the technical centre through return channels, thus creating a closed air circuit.

All measuring steps and phases are handled via a central master control station. There, the equipment under test can be optically screened via monitor while the measuring takes place. Moreover, the developers can get a subjective impression of the acoustic behaviour of the fan or blower via the microphone installed in the test chamber.

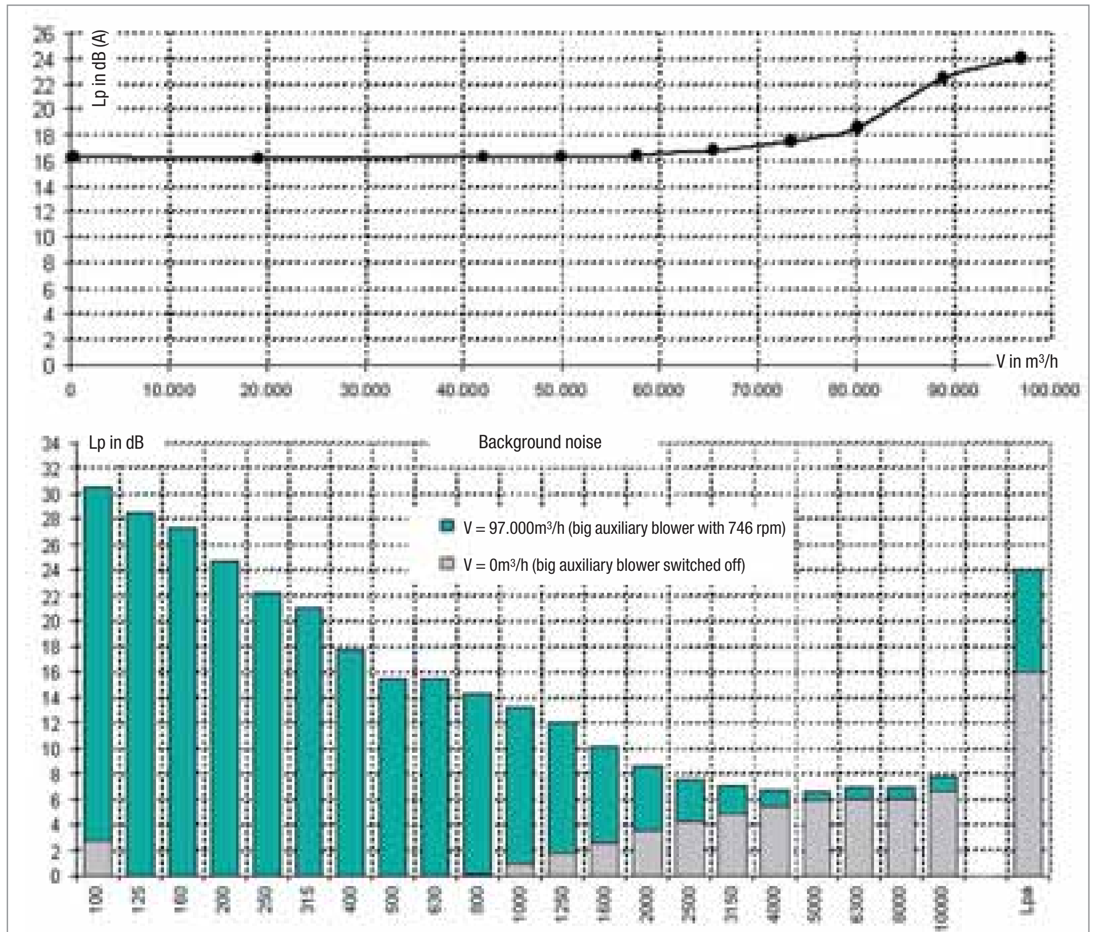


Fig. 4: Background noise (top: summation level against air flow; bottom: third octave band

2. Validation of air performance and sound power measuring

In the third quarter of 2005, all components of the test facility were first put into operation. The first validation phase saw several different norm-conformity tests being carried out, such as establishing the flow profile toward the equipment under test, the total leakage of the test facility, the basic noise level or the acoustic absorption characteristics of the measuring chambers. The second phase consisted of comparative and repeat measuring cycles. Some interesting validation results shall be discussed below.

According to standard [4], the acoustic measuring results are to be corrected once the basic sound level and the measured reading are less than 15dB(A) apart. This correction is automatically effected in the software developed by ebm-papst to collect measuring data. In preparation for this, the basic sound level has to be established. A detailed study revealed that this only depends on the velocity of flow in the test facility. Further parameters, such as speed of auxiliary blower or choke position, have no impact whatsoever. Fig. 4 shows the measured summation level in the test facility against the airflow between 0 and 100,000m³/h at the top. He overall basic sound level is between 16 and 24dB(A). The bottom half of fig. 2 shows the third octave bands in the specified frequency range of 100Hz to 10kHz for airflows between 0m³/h and 97,000m³/h. It is plain to see that the summation level is only determined by the frequencies exceeding 1000Hz when the auxiliary blower is switched off. The case is different with higher air flows: here, the frequencies below 1000Hz play the decisive role.

Comparisons of the air performance curves and acoustic characteristics established via the new test facility with the readings established at other ebm-papst test stations revealed good correlations. Fig. 5 illustrates this for the case of two axial fans of different size. The interesting thing here is that minimally higher air flows are recorded in the new test facility at lower back pressures. The reason for this is that the test stations used up till now could not guarantee the optimal flow towards the equipment under test at very high air flows due to the relatively small dimensions of the air supply chamber.

In January 2006, regular measuring operations at the combined test facility at ebm-papst Mulfingen commenced. Now, having the opportunity to simultaneously carry out norm-compliant measuring of air performance and acoustic power of axial or centrifugal fans and blowers or customer units, design and development cycles are further optimised.

Literature

[1] DIN EN ISO 3745: 2004-05: Acoustics – Establishing acoustic power levels of noise sources via sound pressure measuring – Method complying with accuracy class 1 for low-reverberation rooms and half-spaces
[2] DIN 24163-2: 1985-01: Fans & blowers, measuring performance, standard test stations
[3] ISO 5801: 1997-06: : Industrial fans & blowers – Measuring performance on standardised test stations
[4] DIN 45635-38: 1986-04: Measuring noise on machines; air-borne noise emission, methods for enveloping surfaces, echo chambers and channels; fans & blowers
[5] DIN EN ISO 3744: 1995-11: Acoustics – Establishing sound power levels of noise sources via sound pressure measuring – Enveloping surface method of accuracy class 2 for a basically free sound field across a reflecting plane

World premier at ebm-papst: New test facility for combined air and noise measuring of fans and blowers put into operation

„In January 2006, regular measuring operations commenced.“

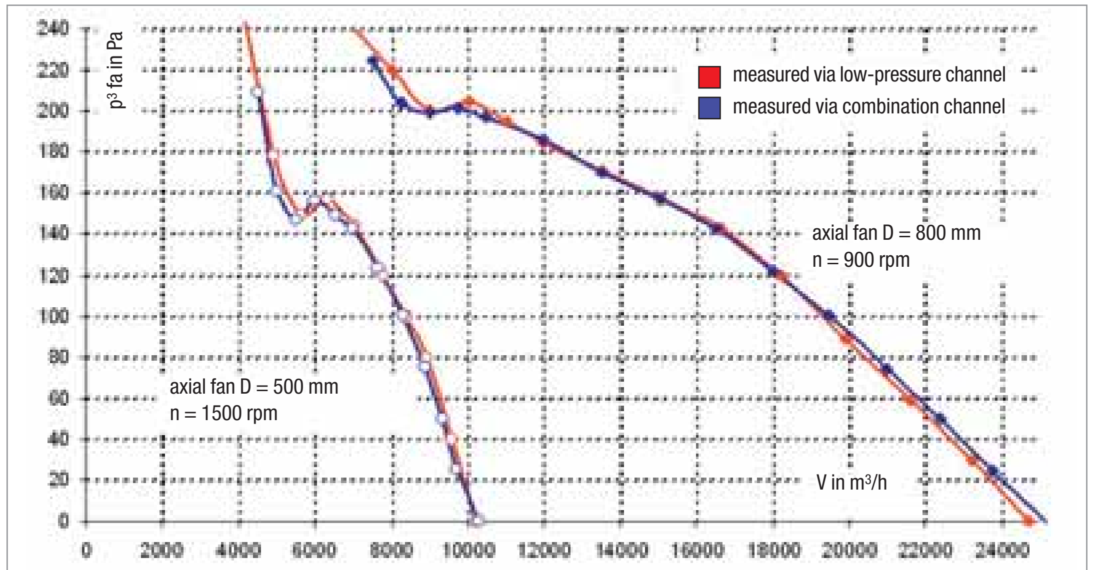


Fig. 5: Comparison: measuring air performance

Dr. Ing. Erik Reichert
Team Manager Development Aerodynamics & Fluerics
ebm-papst Mulfingen GmbH & Co. KG

Exhaust air systems with new pressure control

EC-fan line for rooftop units

Having checked in, any hotel guest will invariably direct his steps to the bathroom unit in his room. Turning on the light will produce a startled look caused by the sudden and unexpected noise that has sprung up. The source of this noise can quickly be determined: a small fan tasked with the job of ventilating the bathroom unit. In order to avoid such disturbing noise and to also save energy, central exhaust air systems with EC rooftop fans and pressure control are used with increasing frequency.

Fig. 1: Rooftop fan as part of a modern exhaust air system

Bathrooms and bathroom units in hotels, whether these are catering for 20 or 2000 guests, are a typical application for exhaust air systems. The one thing they all have in common is that there is no constant und continuous operation required in the course of a single day. The small ventilation fans are especially in action in the morning during breakfast time, throughout the daily cleaning round in the morning, during lunchtime and the check-in and check-out rush, and finally again in the evening. Generally, the ventilation function is coupled with the light switch of the bathroom unit. This means that these fans are not closed-loop controlled, but are simply switched on and, temporarily delayed, switched off again.

Central solutions preferred

Operating individual fans in each bathroom unit not only has acoustic problems, there is a further, even bigger problem than that. As there is no closed-loop control, the fan system is not operated in line with demand, thus consuming far more energy than is actually needed. This problem is a widespread one. The Fraunhofer Institute for System and Innovation Research in Karlsruhe took a closer look at the pan-European market for fans in the power range of up to 500kW. Their comprehensive study was completed in 2005 and came up with the conclusion that many fans in industry, transportation and in building technology could be operated more efficiently, thus saving an annual € 2.6 billion in energy costs. However, as this dissipative mode of operation also offers immense potential for savings, exhaust air technology focused on developing central plants and systems, the so-called variable airflow systems.

The following two factors play a decisive role, When it comes to the most efficient form of airflow controlled exhaust air systems:

1.) The rooftop fan used is operated with speed-control and optimised energy consumption
2.) Speed is adjusted to the actual demand in exhaust air at any given time

„Rooftop fans with integrated pressure control unit offer a number of benefits!“

The optimal solution is using a pressure-controlled system, such as can be used in the hotel application discussed above. For the rooftop fans needed in such systems, ebm-papst Mulfingen GmbH & Co. KG provides centrifugal fans with EC technology. The most significant characteristic of EC-powered fans becomes evident when comparing the efficiency of such a fan with that of voltage and frequency-controlled asynchronous or AC motors: across the entire speed respectively load range, the EC motor of the fan boosts better efficiency. And as the demands on exhaust system fluctuate most strongly in hotels, it is precisely here that EC technology can be used to the best advantage.

Uncomplicated closed-loop control

In many cases, it is necessary to adjust fan speed to the ventilation system or the ventilation demand. In order to make just this possible, Systemair GmbH in Windischbuch co-operated with ebm-papst to develop a new rooftop fan with integrated pressure control unit. This pressure control unit consists of a terminal box with high-strength cable glands and contains a pressure sensor (0 to 500 Pa), the control equipment itself as well as two set point adjusters for day and night operation, to be activated as needed.

Fig. 2: The EC fan is situated at the end of the duct system of such a central exhaust air system

In a hotel, the exhaust air pipes of the bathroom units are brought together in a shaft-like duct system. At the end of this system, on the rooftop, the EC-controlled exhaust air fan is situated. In the duct system itself, the pressure sensor permanently determines the required airflow. This, however, can only work if there are electric valves mounted in the prefabricated bathroom units that open once the light is switched on. Open valves cause the pressure to drop in the system. As the closed-loop control is set to keep pressure constant, the fan is automatically controlled back to the preset pressure via airflow increase.

Fig. 3: New pressure control unit from ebm-papst for the application in rooftop fans

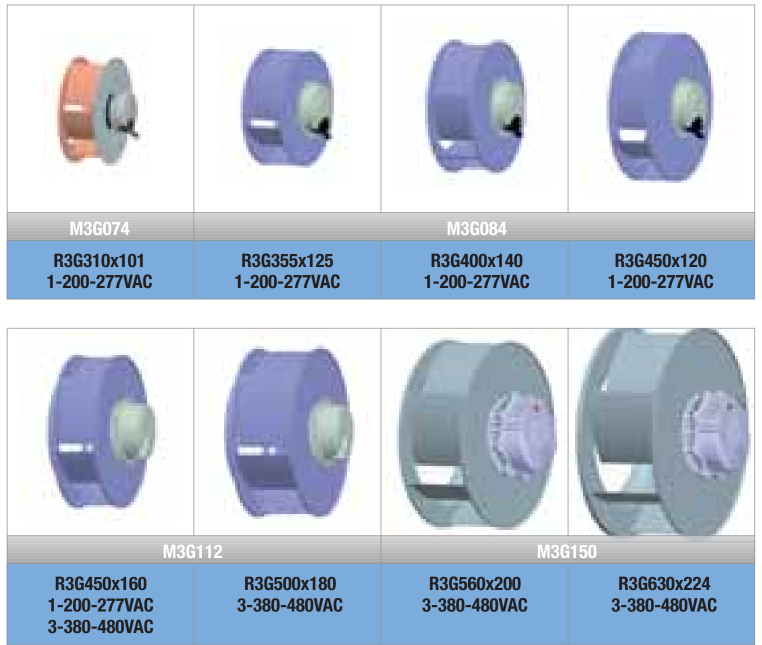


Fig. 4: ebm-papst as EC-pioneer has developed a complete range of centrifugal high-performance fans with EC motors. 8 different sizes cover the entire performance range of up to 3kW.

Manifold benefit for all

Rooftop fans with integrated pressure control unit offer a number of benefits and advantages. They require only that amount of energy that is actually needed and help to reduce and avoid CO_2 emissions at the same time. Moreover, the source of noise is transferred from inside the rooms to the exterior. And the speed adjustment feature also results in minimal air-borne noise being emitted. Planners and design engineers can enjoy reduced time and planning effort due to the complete system now available. And terotechnology and mechanical engineers benefit from this complete system, as the integrated pressure control unit minimises the amount f time and money spent on wiring. There is only need for a connection to the line supply. With EC-technology, fan and pressure control unit operate on all 50Hz and 60Hz mains at all conventional line voltages all over the world. This means that the fans can be used throughout the world, making planning and mechanical engineering a lot easier.

An investment that soon pays off

It is undisputed and proven that fans in EC-technology are the most cost-efficient solution in terms of operating costs. Having the lowest power input and being also low in noise, this solution should be generally preferred to a decentralised design.

The new and complete system „EC-driven rooftop fan including pressure control unit“, available since January 2006, represents a package development offering the most cost-efficient solution with respect to investment costs as well. Compared to a pressure-controlled AC solution of similar quality, there is practically no difference in primary costs any longer. Yet the extra costs incurred when wiring up conventional AC technology are no longer required with the EC solution. EC-driven fans offer excellent scope for brilliant solutions in building engineering, as demonstrated with the central exhaust air system. This applies not just to planning of new buildings, but also to reconstruction and building renovation.

Fig. 5: Easy to spot: The pressure sensor inside the control unit that monitors the ventilation requirement in the duct system

EC-technology in comparison

EC-fans go soft on energy when operated in heating, air-conditioning or ventilation applications. Other than with conventional AC-technology, the EC fans are driven by an EC motor, the main feature of which is the electronic control equipment - the so-called commutation electronics. Due to their design principle, these motors run in synchrony, have no slip and, therefore, no slip loss is incurred; an advantage over conventional asynchronous systems with voltage or frequency control. Their commutation electronics ensure that EC-fans have continuous closed-loop control in general, and so their speed can be adapted to the demands of the ventilation plant or to the individual process at any given time. The diagram shows a comparison in energy costs between EC technology and the control variants voltage control (transformer and phase angle control) and frequency inverter as used with AC technology. The advantages in terms of energy savings are especially striking in the partial load range.

The integrated power electronics, together with the necessary EMC component line filter, and motor protection as well as open- and closed-loop control functions in the motor itself make for a compact fan unit. There is substantially less need for installation space than with conventional technology. Moreover, no additional time or money needs to be wasted on installation or an extra switch cabinet. Installation mistakes are thus avoided. Motor design and new commutation approach guarantee a minimum of vibrations and low noise of the overall application. Additional anti-vibration mounts for the fans become totally unnecessary.

Compared to conventional technology, this integration results in a substantially cost-efficient system price while retaining all the functions. Fan applications with EC-SYSTEMS can also be operated on all 50Hz and 60Hz mains at all regular line voltages throughout the world, with unvarying performance. This means that the same product can be used throughout, regardless of line voltage and frequency. Unit manufacturers exporting their products can thus enjoy a reduction in type variants – an important competitive edge in international business.

Dipl.-Ing. Andreas Fessel
Project engineers / Sales
ebm-papst Mulfingen GmbH & Co. KG

„EC-SYSTEMS – an important competitive edge in international business!“

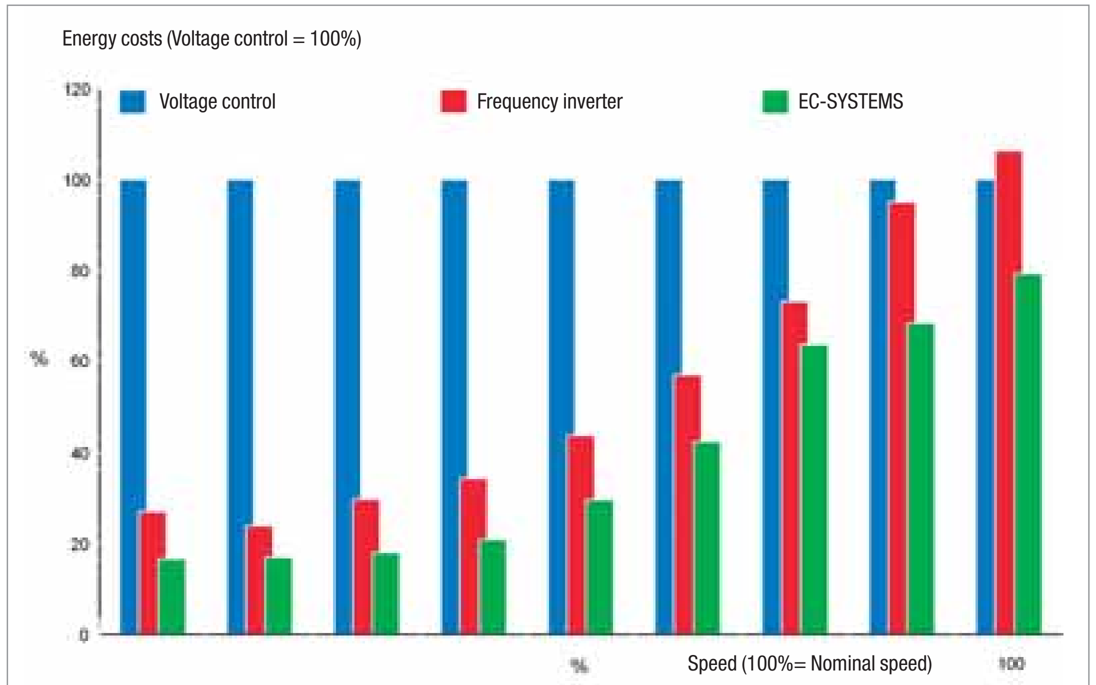


Fig. 6: Comparison of operating costs between various fan drive systems

Guidelines for choosing the correct drive

Even the best design construction is stuck at a standstill without a drive. It is modern electrical drive designs that get mechanics moving. Electromechanical motion can be created in a variety of ways. The requirements of a drive can best be met using a number of different types of motor. The choice of DC, AC or three-phase current, internal or external rotor, brush motor or electronically commutated, all go to ensure the most suitable adaptation to each application.

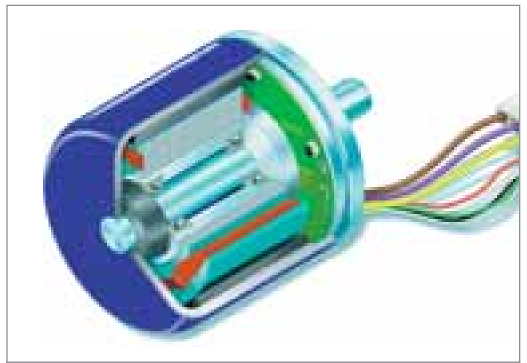


Fig 1: Sectional view: external rotor motor

ebm-papst, with its wide range of standard motors, is always able offer each of its customers the ideal design of drive for their specific application. This range includes brush or electronically commutated DC motors through to AC motors. Meticulous quality assurance, both in design and production, accredited suppliers and qualified customer service personnel, all ensure drive solutions at the highest level.

Types of construction

The manufacturer's product range is based primarily on two different motor concepts. The first is the external rotor motor that has a comparatively high torque and the other is the internal rotor motor, which thanks to its low inertia is particularly suited to highly dynamic applications. In external rotor motors a cowl-shaped rotor with an integrated motor shaft revolves around a stationary stator, which supports the windings (Fig 1). Thanks to the greater diameter of the rotor on which they are fixed, the permanent magnets provide a larger magnetic volume. This, together with the special concentration of magnetic flux and the greater air gap diameter, result in a higher torque for the same electromagnetic force than with internal rotor motors. However the increased mass of the external rotor motor does entail a higher moment of inertia and so the dynamic properties of such motors are not so good.

If it is a question of high dynamic capabilities, that is to say quick changes of speed or direction of rotation, then the internal rotor motor has to be the first choice. Here the magnets together with the magnet yoke are situated directly on the shaft and rotate in the stator support housing (Fig 2). The use of high-energy magnetic materials guarantees a high power output with the smallest size of construction. Alongside these two alternative types of design, modern drives also have differ in their electrical construction.

DC diversity and ...

EC direct current motors can either be constructed as small powerful internal rotor motors or as external rotor

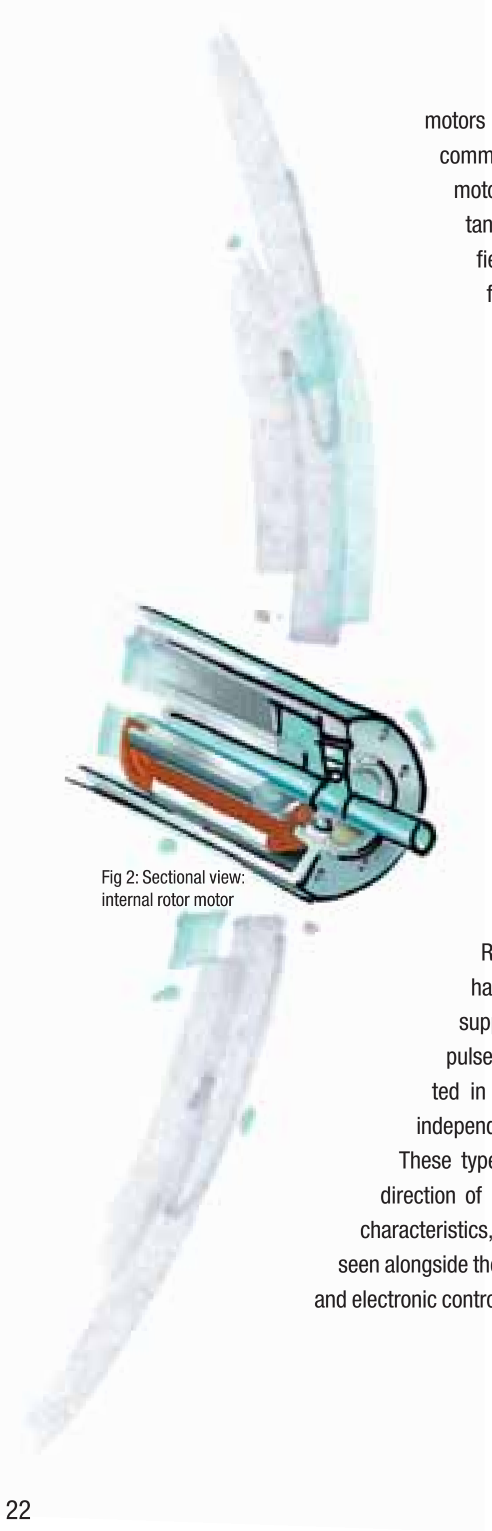


Fig 2: Sectional view: internal rotor motor

motors with high torque. The electronic commutation permits different types of motor construction. In the simple reluctance motor a pulsating alternating field provides the necessary motive force. An auxiliary torque bridges the torque gaps using the magnetic reluctance effect between the permanent magnetic rotor and the soft-magnetic stator. The principle of operation of this reluctance torque is based on the deviation of the air gap from the symmetrical rotation circle (Fig 3a). These motors are simple to build and only require either two or four power transistors for the control; however they only permit one direction of rotation and have a low load torque when at rest. The main areas of application are fans, blowers, compressors and centrifugal pumps.

Rotating field motors on the other hand use 3-phase windings, which are supplied with current using 3- or 6-pulse circuits (Fig 3b). The torque generated in this way is virtually constant and independent of the position of the rotor. These types of motors can be driven in any direction of rotation and have excellent control characteristics, but these advantages have to be seen alongside the higher expenditure on construction and electronic controls.

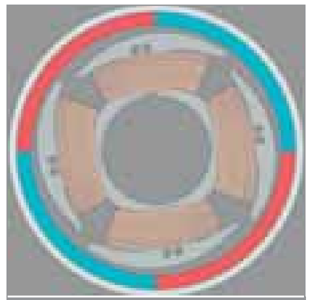


Fig 3a: Schematic drawing: reluctance motor

... AC-Versions

Different design concepts also exist for AC motors. Thus the single-phase shaded-pole motors with squirrel-cage rotors have a two pole asymmetrical design. Their standard direction of rotation is clockwise and the armature normally runs in maintenance-free sleeve bearings. The simple construction makes it the most economic solution to many standard tasks that do not require a significant level of torque or power output.

Applications requiring higher performance levels can be accomplished using capacitor motors. These are two or four pole single-phase motors with squirrel-cage rotors. Their winding is two-phase with one phase connected via the running capacitor. The main and auxiliary windings are symmetrical allowing the direction of rotation to be changed without loss of output. They too can be constructed as external rotor motors. With shaded-pole motors and with capacitor motors the load curve changes with the mains frequency. Both can still however be adapted constructively for use with various frequencies and voltages.

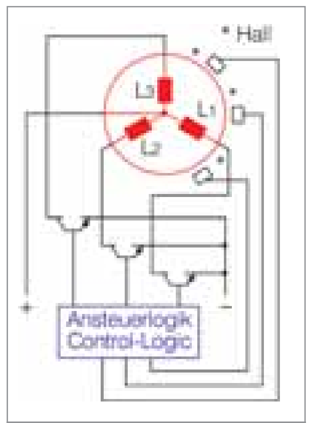


Fig 3b: Schematic drawing 3-phase motor

ebmpapst

„AC-Motors – the simple construction makes them the most economic solution!“

BCI-Motoren – especially efficient and particularly suitable for lower speeds

Brush commutated

Even long-serving motor designs have inherent potential for innovations. So the especially efficient BCI motors, with their exceptionally low motor cogging torque (< 2 % of the nominal torque), offer outstanding value for money. The modern armature design with an 8- or 12-piece commutator is particularly suitable for lower speeds whilst offering exceptionally smooth running characteristics. The service life of the carbon brushes for nominal operation exceeds 3,000 hrs. and EMC protection is standard. Improved radio interference suppression of the motor can be achieved using an additional PCB. Precision ball bearings with long-term lubrication and a protective cover against carbon dust entry reduce wear. Industry standard zinc die cast flanges allow for universal mounting.

The standard operating voltage is 24 VDC and the output power ranges from 13 W to 93 W at 38 to 270 mNm nominal torque (starting torque 190 to 2500 mNm). Depending on the model, the speed goes from 3,300 to 3,100 min-1. Optionally the motors can be ordered with planetary, worm or spur gearboxes. Spur gearboxes offer gear ratios in stages from 18.8:1 to 432:1, planetary gearboxes from 3.2:1 to 180:1 and worm gearboxes from 3:1 to 68:1. Depending on the motor and gearbox type, the torque values go up to 18 Nm. An optional spring-operated friction face brake, add-on magnetic pulse generators (2, 4, 6 and 12 pulses per revolution with A- and B-channels) and an optoelectronic 2-channel incremental encoder round off the BCI standard product range (Fig 4).

Fig 4: Photo BCI family of motors

A wide variety of EC motors

The electronically commutated VARIODRIVE motor with its integrated commutating electronics is universally suitable for all kinds of tasks. Constructed as a 1- or 3-phase external rotor motor in five sizes from 3 up to 100 W it offers

ebmpapst

EC-Motors are ideal for use in high-quality medical and office equipment!

scaleable power for many drive tasks. Standard industrial voltages from 12 to 28 V are commutated via the internal electronics in line with internal or external selections. The high efficiency, wide usable speed range, together with high torque constancy, no vibration and virtually noiseless running mean that this motor is ideal for use in high-quality medical and office equipment. Spur gear motors broaden the spectrum of application. In addition the commutation electronics, the VARIODRIVE Compact models have additional speed control electronics with an integrated microprocessor in the motor housing. Standard industrial interfaces enable fast integration into existing controls. The 3-phase motors with outputs from 7 to 115 W and 4-Q PI controllers adapt themselves perfectly to the required drive characteristics. Electronic design and motor layout tailored to customers' requirements are possible, as well as optional external control electronics or special gearbox versions (Fig 5).

The 3-phase ECA external rotor motor is controlled via external electronics. The four different sizes offer output power from 10 to 340 W. This series of maintenance-free motors is renowned for its excellent synchronous operation characteristics and easy control. Once again matching gearboxes open up the

Fig 5: VDC family of motors

application potential and permit torque values up to 24 Nm. Recourse can be made to M3G motors if even greater outputs are needed. These powerful EC motors, available in 5 different sizes, bring between 50 W and 3 kW to the shaft at torque values between 10 and 2000 Ncm. Precision ball bearings and determination of rotor position via 3 Hall sensors ensure silent running and excellent speed stability even at very low speeds. Depending on the model, the nominal voltage can be selected for 24, 48 or 110 VDC, or 230 V AC with 1-phase or 400 V AC with 3-phase supply. Available options include integrated or external electronics with PWM input or 0...10 V linear input, locked-rotor protection, soft start and other functions.

„Dynamic tasks are undertaken by the compact ECI motors."

Dynamic tasks are undertaken by the compact ECI motors. 3-phase, electronically commutated internal rotors with neodymium magnets offer a power output range from 90 to 254 W at a nominal voltage of 24 V. 3 Hall sensors detect the position of the rotor and precision ball bearings ensure a silent maintenance-free long service life. Various gear types, such as worm or planetary gears extend the range of possible applications. Accurate positioning control can be achieved using the option of an encoder, which fits within the diameter and offers up to 4,000 increments per revolution, or a particularly rugged 2-pole resolver with 12 bit/revolution resolution (Fig 6).

AC motors

If AC motors are required, then the tried and tested shaded-pole and capacitor motors of the EM and KM series are the answer. The standard versions of the internal rotors work on 230V, 50Hz; other frequencies and voltages are possible on special request. The rugged, maintenance-free EM motors offer power outputs from 0.5 up to 14.5 W with S1 operation (continuous running). The rated speed at 50 Hz lies between 2100 and 2600 min -1. If greater power output and/or operation in both directions is required, then these can be handled by capacitor motors. Outputs from 31 up to 176 W (S1) at speeds from

Fig 6: ECI internal rotor motors

2700 min -1 (2-pole) or 1350 min -1 (4-pole) can be demanded at the shaft. As geared motors they have ratios of 10.5:1 up to 882:1 (series Gtg 50, up to 12W and 5 Nm) or 15.5:1 up to 275:1 (series Gtg 92, up to 90 W and 15Nm).

The AC motors are available as external rotors in sizes 068 and 074 with a short compact design; they offer excellent constant speed and very low noise level.

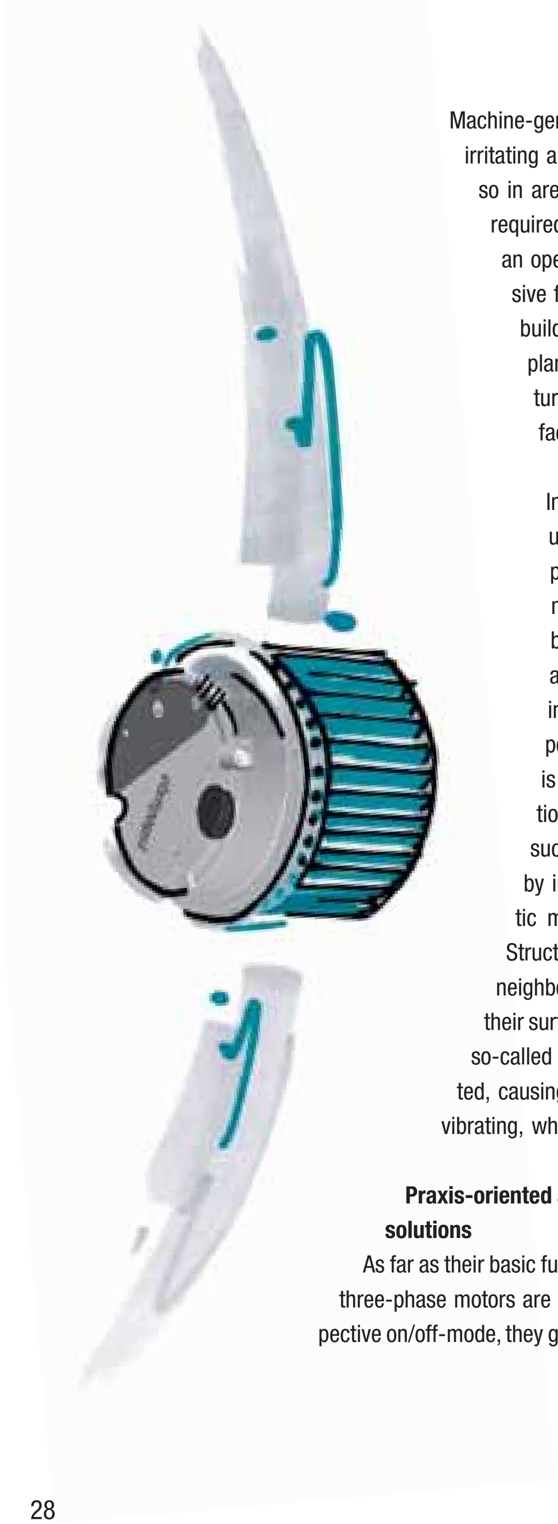
For applications in thermostats or drink coolers the motors with a power output in the range of 5.3 to 200 W can also be ordered with a stainless steel shaft. The speed can be

Minimal noise and maximal airflow

very easily controlled by varying the operating voltage, for example by means of fixed resistors, autotransformers or capacitive resistors. There are also motors with electronic control for more demanding applications.

It is often very difficult to find the right motor for each drive requirement. The user needs to be able to turn to a competent partner, who has the broad range of motors available to help him solve his applications quickly and securely. Moreover following the motto "everything from a single source" can help avoid unnecessary friction arising between purchasing, stores and handling.

Dipl.-Ing. (FH) Markus Kuner
Sales Manager Electronic Systems & Drive Technology
ebm-papst St. Georgen GmbH & Co. KG



Machine-generated noise is often felt to be irritating and annoying. This is especially so in areas where a quiet ambience is required. For this reason, as low-noise an operation as possible is the decisive factor in the air-conditioning of buildings, with telecommunication plants or in refrigeration. Manufacturers of ventilation units are thus faced with a special challenge.

In order to make the ventilation units display a “perfect acoustic performance”, the motors used may neither excite structure-borne noise nor may they emit air-borne noise, and this totally independent of the mounting position. Structure-borne noise is defined as mechanical vibrations in solid bodies. With motors, such vibrations are mainly caused by irregularities in electro-magnetic moments (torques) and forces. Structure-borne noise spreads to all neighbouring components and causes their surfaces to vibrate, too. This way, a so-called “loudspeaker effect” is created, causing the ambient air to also start vibrating, which generates air-borne noise.

Praxis-oriented alternative to conventional solutions

As far as their basic functional principle is concerned, three-phase motors are especially low in noise. In respective on/off-mode, they generate a very even and almost non-vibrating magnetic rotary field; the noise-generating vibrations are thus at a minimal level. However, supplying the three-phase mains and the more complicated wiring and open and closed loop control are often extremely expensive. This is why the three-phase motor solution hardly made its way into practical realisations.

Instead, a frequent attempt was made at improving the acoustic performance of the drive within the system by providing a mechanical anti-vibration mount individually adapted to the relevant unit. However, constantly increasing specifications as to noise reduction have made this approach reach its limits. Tougher specifications result in more complex anti-vibration measures, and the more complex these become, the more they cost. Relying on their long years of experience and expertise in this field, the fan and motor specialist ebm-papst Mulfingen has developed a new EC motor offering the possibility to combine optimised noise performance based on a new design (figure 1) and easy and uncomplicated connection technology with a favourable cost/performance ratio. The integrated electronics of this EC motor make for simple open and closed loop control options.

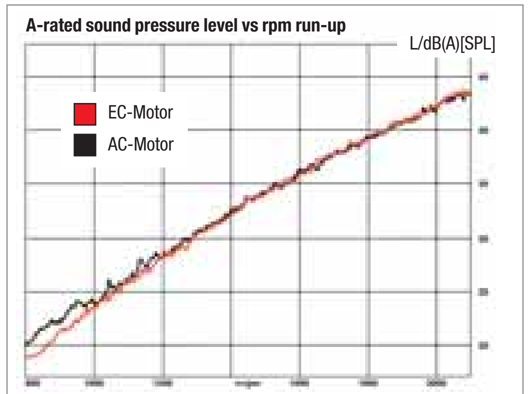


Fig. 1: Optimal acoustic performance of an AC and an EC motor

„EC motors meet toughest demands as to reliability and service life.“

EC-Motors – Compact, durable, and easy to install

Acoustic insulation and protection against environmental influences

In order to optimise the acoustic performance, the stator of the new 3-core EC motor in size 55 was completely encapsulated. In conjunction with the special commutation approach generating very symmetrical magnetic fields, the encapsulation material drastically reduces the generation of vibration and the emission of noise. An additional mechanical anti-vibration mount is no longer necessary. Combined with the application-specific housings and impellers, this motor can be mounted in any conceivable position.

The concept of the stator encapsulation offers yet another advantage: the encapsulation material also protects the control electronics integrated in the motor (figure 2). Thus, the motor complies with the specifications of protection type IP 54, i.e. it is unsusceptible to dust deposits and protected against spray water. Ambient temperatures may range between - 20 °C and + 60 °C.

Compact, durable, and easy to install

This low-noise motor is available in stack lengths 73 and 85 mm, with performance ranging from 30 to 85 W. Due to the electronics being integrated, these motors are very compact. They are already used in axial and centrifugal fans and blowers (figure 3). Due to the external-rotor design and the ball bearing construction already proven its worth in a multitude of applications, these compact motors comply with the toughest specifications as to reliability, durability and service life. Their top quality standard is reflected by the fact that ebm-papst complies with TS 16949, and has been doing so since their first certification in March 2003. This certification automatically makes a company comply with the specifications according to ISO 9001:2000 and answer to the basic specifications of the automobile industry. The most important aspect in the decision for compliance with these standards was the ebm-papst maxim to always meet customer specifications, not only those of

Fig. 2: Constructive principle of a centrifugal fan with EC motor in size 55. The encapsulation of the stator reduces noise emission and serves to protect it against environmental influences at the same time. A mechanical anti-vibration mount is no longer necessary.

Fig. 3: Possible applications of the new EC motor in size 55 in forward and backward curved centrifugal fans

direct customers, but right down to those of the end consumer.

With the new motors, special attention was also paid to arrive at the lowest possible installation complexity. The electronics integrated in the motor housing can be directly connected to the 230 V mains; the three-phase mains is no longer necessary. The amount of air is controlled via speed. The set values can be entered continuously via PWM input or via a 0…10 V signal. In case speed needs to be manually adjusted via setting button, only a single potentiometer needs to be connected. The supply voltage necessary for this is provided by the motor itself, via electrically isolated voltage output.

The new and low-noise motors in size 55 round off the EC motor range at the lower end. The five sizes now available (55, 74, 84, 112, and 150) cover the performance range of 30 W up to 3 kW.

Dipl.-Ing. (FH) Gunter Streng
Head of Platform Development
ebm-papst Mulfingen GmbH & Co.KG

Art.-Nr. 40010-7-8811 - SC-02/06-3'

ebm-papst
Mulfingen GmbH & Co. KG

Bachmühle 2
D-74673 Mulfingen
Phone +49 (0) 7938/81-0
Fax +49 (0) 7938/81-110
info1@de.ebmpapst.com

ebm-papst
St. Georgen GmbH & Co. KG

Hermann-Papst-Straße1
D-78112 St. Georgen
Phone +49 (0) 7724-81-0
Fax +49 (0) 7724-81-1309
info2@de.ebmpapst.com

ebm-papst
Landshut GmbH

Hofmark-Aich-Straße 25
D-84030 Landshut
Phone +49 (0) 871-707-0
Fax +49 (0) 871-707-465
info3@de.ebmpapst.com

www.ebmpapst.com

ebmpapst