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NEW IDEAS AT A GLANCE

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Editorial

Dear customers, partners and friends of ebm-papst:

After the boom year of 2006, the heating systems business slowed significantly in 2007. In Germany, the discontinuation of government subsidies for first-time home buyers and the increase of the value-added tax have caused a steep drop in the number of building permits. The mild winter so far and the Europe-wide discussion about the use of renewable energies have made the situation even more difficult. Markets such as the pellet heating industry collapsed almost completely in 2007. Will the final straw now come from the current debate about the use of filters? What will 2008 have in store for us?

We at ebm-papst have an optimistic outlook on the future, viewing the current developments as both a challenge and an opportunity. In time for the Mostra Convegno trade fair in Milan, we have turned the current trends into a range of innovative products and have got them ready for series production.

With the expansion of the NRG series for larger heating capacities, the HRG for oil-fired applications and, not least, the LambdaConstant for state-of-the-art upper heating value burners, ebm-papst Landshut is keeping up with the current demand for energy savings with reduced emissions at the same time. The new iQ-motor and the energy-saving motors from ebm-papst Mulfingen replace energy-hungry shaded-pole motors in refrigeration technology applications and can easily replace existing units. In axial fans, ebm-papst Mulfingen presents the new HyBlade® series, which attains substantial improvements in terms of noise and efficiency. These are only a few examples.

The ebm-papst Innovation Centre in Landshut will soon open its doors. In a total of 2,000 m² of space, our employees will have access to state-of-the-art equipment and development laboratories for operating gas-fired units or testing a wide variety of gas types. This gives us an even better opportunity to work on optimising gas-fired boilers for you, our valued customers, and to partner with you in implementing LambdaConstant in your devices. We will also manufacture the new technology in our Innovation Centre, in a new 1,000 m² production area.

As you will see, at ebm-papst, we will continue to insist on innovation, quality and service. We would be pleased to present our new products to you in person.

I hope that you will enjoy reading our new magazine, tech.mag, and that it will provide you with many new and interesting ideas.

"We insist on innovation, quality and service"

Stefan Brandl
Managing Director
ebm-papst Landshut GmbH

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Saving energy in refrigeration and air-conditioning technology

Image 2: Use of energy-saving fans in refrigerated cases

Today, energy savings have become an important issue in almost all areas of life. Refrigeration and air-conditioning technology is also seeing the effects of this trend. Demand for energy-efficient systems is increasing worldwide, and in more and more cases is even required by law. Therefore, EC motors have become ever more prominent as drive solutions for the fans used in refrigeration and air-conditioning technology, and are actually required by some users' specifications. Their high efficiency allows energy consumption to be reduced by up to two-thirds. At the same time, carbon dioxide emissions are, depending on the application, immediately reduced by several tonnes. This reduces environmental impact and keeps money in the user's pocket.

EC motors have become more prominent as drive solutions

Since air-conditioning and refrigeration systems are operated with high duty cycles, energy savings are particularly noticeable in this area. However, there are considerable differences between applications. For example, the large condensers that are usually installed on supermarket building exteriors (image 1) place different demands on the fans used than do refrigerators or refrigerated cases (image 2, see left). For each of these fields of application, “customised” energy-efficient EC fans now exist that feature outstanding reliability,

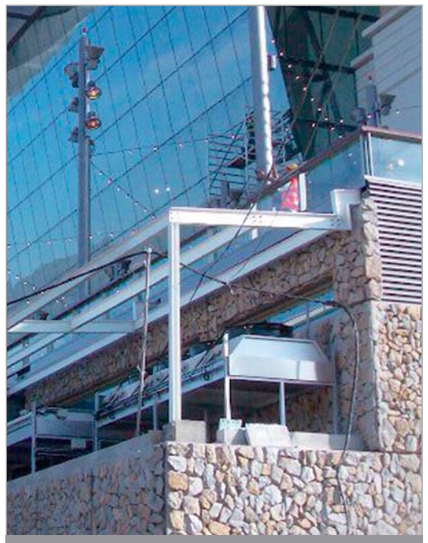


Image 1: Application example of a condenser

maximum efficiency and low-noise performance. The multifaceted product range of motor and fan specialist ebmpapst Mulfingen includes energy-efficient fans for virtually every power range needed in refrigeration and air-conditioning technology.

Compact energy-saving fans for refrigerated and freezer cases

A typical example is the energy-saving motor (ESM, image 3, see page 6), which has been developed primarily for fan applications in refrigerator or freezer cases or bottle coolers. The energy-saving motor is based on the proven external-rotor motor principle, with the rotor turning around the stator within. It is used in axial fans with a 200 mm diameter. The new sizes 230, 250 and 300 have

“The energy-saving fans are robust, durable and practically maintenance-free!”

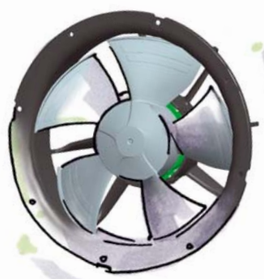
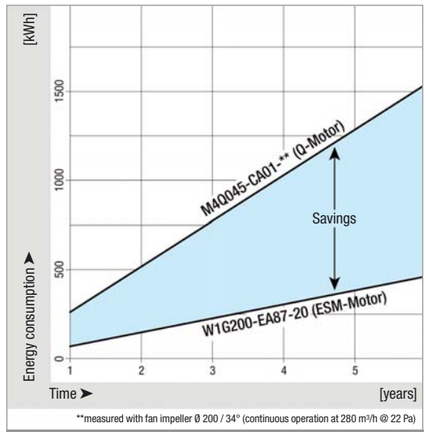


Image 3: Energy-saving motor, used in an axial fan with a diameter of 200 mm

been added to the highly successful W1G200 model. With their new plastic rotor, which has been optimised according to aerodynamic requirements, the fans now work even more quietly and require no varnish – a particularly environmentally friendly feature. New development strategies allowed the “time-to-market” to be drastically reduced during development. It took only one year to get from idea to perfected product, an often time-intensive journey. At the same time, during product development, adaptations could be incorporated directly into the development work at almost every stage. Compared to the commonly used shaded pole motors, energy-saving motors are three times as efficient.

Image 4 shows a comparison of both motor types. At the operating point with a speed of 1300 rpm, the energy-saving motor has a maximum efficiency of more than 65 %, which reduces the input capacity by about one-third compared to a conventional shaded-pole motor. However, higher efficiencies also mean that less waste heat is given off into the surrounding area. This means that less cooling power must be generated in the first place – and thus additional energy savings.



**measured with fan impeller Ø 200 / 34° (continuous operation at 280 m³/h @ 22 Pa)

Image 4: Comparison of curves of ESM and shaded-pole motors

Quiet, robust and reliable

Furthermore, energy-saving fans that provide between 5 and 20 W of output power have some other attractive features. For example, the blades, which have been optimised according to aerodynamic criteria, are very quiet and can easily be connected by simply plugging them in. In addition, motor speeds can be set via a programming interface. A second working speed – for night mode, for example – can be triggered via a 230 V input.

The energy-saving fans are robust, durable and practically maintenance-free. Their life expectancy is rated as over 40,000 hours, corresponding to over 4.5 years of continuous operation. A sealed housing that meets the requirements of IP54 protects the electronics. The axial fan also meets the requirements of protection class 2[1].

[1] Device in which the protection from electric shock is provided not only on the basic insulation, but in which an additional safety measure, such as double or reinforced insulation, is present. No device for connecting protective equipment is required.

Saving energy in refrigeration and air-conditioning technology

Image 5: EC axial fan with 910 mm impeller diameter and 150 motor

High-performance EC fans: energy-efficient and quiet

Even for applications that require high performance, today's EC fans are an ideal match. High-performance EC fans in the kilowatt range have been developed especially for use in cold storage areas or on condensers (image 5). The electronically commutated three-phase motors work with up to 90 % efficiency, thus attaining significantly higher values than most voltage-controlled asynchronous motors in this size. They supply up to 5 kW of power and are used in axial fans (with diameters up to 1 m) and in backward curved centrifugal fans (diameters up to 630 mm).

Moreover, their design principle means that EC motors work extremely quietly. This is often an important argument for supermarket operators, as their stores are often in residential areas where noise is undesirable. To optimise the noise characteristics, the motors' electromagnetic circuit has been completely redeveloped. Combined with a special commutation technique, vibrations and noise emissions have been drastically reduced. An additional mechanical anti-vibration mount is no longer necessary. The motors, combined with the corresponding housings and impellers, can be installed in various positions. They fulfil the requirements of IP54, and thus are insensitive to dust deposits and splash water. Permitted ambient temperatures may range from –25 °C to +60 °C.

Integrated power electronics and network capability

All of the power electronics are integrated into the motors. They are triggered by the control unit via a 0-10 V signal. The fans are then controlled according to the values measured by the external sensor. The set values for the speed, and thus for the air volume, can be configured continuously via the PWM input or via a 4 to 20 mA signal. If you need to change the speed manually using an adjusting knob, simply connect a potentiometer. The necessary supply voltage is provided by the integrated motor electronics directly via an electrically isolated voltage output. The closed loop speed control also helps to reduce the noise emission and save energy, as the fans only ever have to provide the air volume that is actually required.

In addition, intelligent fan systems can easily be created by networking multiple drives (image 6, see page 8). The corresponding interfaces, such as RS485 and the 0 - 10 V output for the slave activation, are integrated at the factory. This drastically simplifies the setup of control systems like those commonly used for condensers in refrigeration and air-conditioning technology. Only relatively few components have to be installed, which also helps to keep costs low. Other than the fans equipped with intelligent motors, the only other thing you need is a pressure sensor. You do not need an additional controller, for example. Safety is ensured by integrated over-temperature protection for motor and electronics, overvoltage shutoff, a monitoring circuit for phase failure as well as locked rotor protection and an EMC and mains filter. The integrated power electronics are compatible with all rated input voltages between 380 and 480 V. The air performance and efficiency are

“The closed loop speed control helps to reduce the noise emission and save energy”

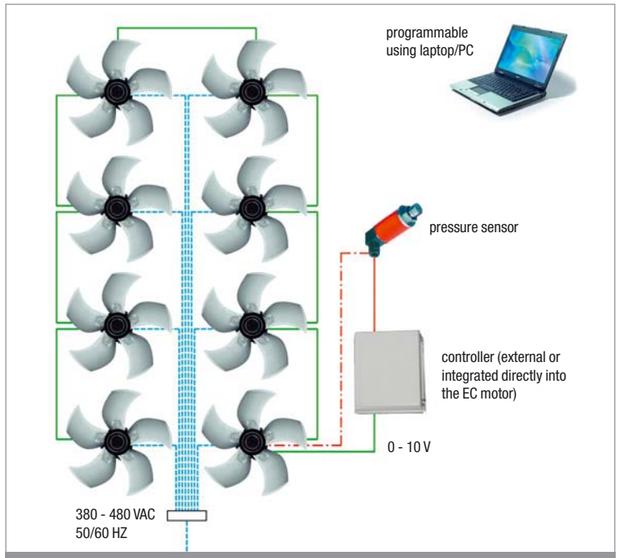


Image 6: New master-slave system (group control) with EC fans

unaffected by this. Compared to asynchronous motors, this substantially reduces the number of variants, making the same fan suitable for a wide variety of requirements. This is an important argument for using EC fans. Of course, they are suitable not only for condensers, but other applications as well.

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

Modern technical facility management in the Laimer Würfel

Image 1: new building complex “Laimer Würfel” in Munich
(Source: Frick Krüger Nusser Plan2 GmbH)

Decentralised ventilation system with EC technology as new alternative:
Modern technical facility management in the Laimer Würfel

"The decisive fact for us was the low energy consumption of the EC technology"

Planning functional buildings is project business, i.e. rather an individual matter. This is equally true for the technical facility management used, especially ventilation and air-conditioning. A new building in Munich now features a decentralised ventilation concept using state-of-the-art fan technology. What does this mean?

Large buildings, be they hospitals or office complexes, public facility or airport, require sophisticated concepts for ventilation and air-conditioning. There are two possibilities: either the air is filtered, heated, cooled and humidified or dehumidified at a central spot. In this case, fresh and exhaust air need big ducts to pass through the entire building to the individual floors or rooms and back. Or, as second possibility, air is directly processed on site, i.e. in the room itself. In doing so, only the medium needed to condition the air is warmed or cooled centrally and is then fed into each single room of the building via tubes of small diameter. In doing so, air is directly handled through the facade. The major advantage lies in the fact that, other than with air, considerably more heating respectively cooling energy can be transported via water due to its higher heat capacity (a factor of about four). Moreover, distribution across even long distances in insulated tubes results in far lower energy losses than with large air ducts.

New reference application in Munich

One of the latest and surely most representative buildings using a decentralised ventilation concept is the Laimer Würfel (image 1, see page 9). The building, designed as cube or die (hence its name) is located at the Landsberger Straße in Munich. The cube has restaurants and shops on the ground floor and offices in the upper floors. These can be adapted to individual requirements in terms of interior design or utilisation. This multifunctional concept is supported by modular and decentralised parapet units specifically further developed for this project by TROX/FSL (Image 2, see page 10). They consist of frame housings, 1,600 of which had already been integrated in the facade at a very early construction stage and which were finally fitted with heat exchanger unit, thermal guiding device and functional box. Apart from 800 functional boxes with the modes ventilation (aeration and de-aeration), heat recovery as well as heating, cooling and filtering of supply air, another 540 further frames were fitted with secondary air boxes to supply all the required heating and cooling functions. For the time being, the remaining 260 frame housings are fitted with sound and heat absorbing boxes. Here, the functional boxes for aeration and de-aeration or secondary air can be retrofitted as needed and at small expense. Cooling, heating and ventilation can thus be individually controlled room by room and thus match the high demand for comfort and flexibility future users may have. The only difference between this and a 100 % air-conditioning system lies in humidity control. Here, room air can be dehumidified in summer in an unregulated way, with the generated condensate being discharged via facade. Humidifying supply air in winter would only be possible using an additional module.

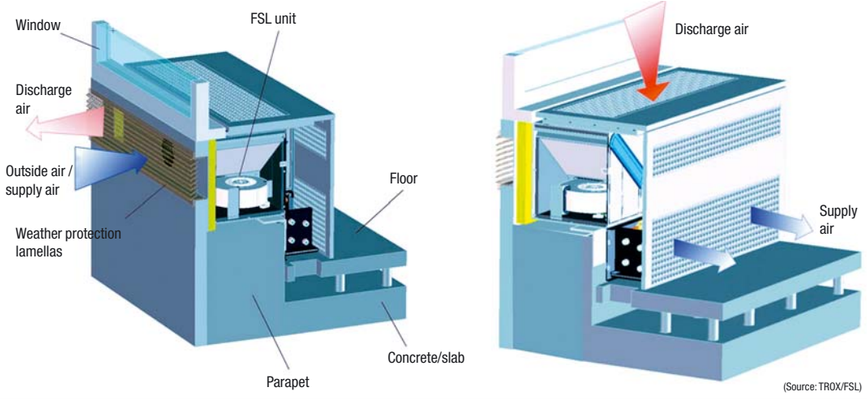


Image 2: Functional diagram of the parapet units used given in two different views

Image 3: EC fan
G3G146CC11-15

Double fan mission

To handle supply respectively discharge air in the room, the functional boxes have two ebm-papst Mulfingen fans installed (image 3). Knowing they have extremely economical EC motors, TROX/FSL deliberately went for this energy-efficient technology. "The decisive fact for us was their low energy consumption respectively their high efficiency, as well as their optimised acoustics. Being able to keep airflow constant despite fluctuations in pressure differences was another, secondary aspect", explains Dirk Scherder, team manager for FSL products with TROX. Since back in 2004, TROX has mainly been using EC fans in their parapet units. With the Laimer Würfel, special requirements had to be met. As Scherder continues: "Almost all the functions of an air-conditioning system had to be fitted into the smallest possible space" (image 4).

Another special feature making sure that airflow is always adjusted to the actual demand is the patented "non-sensor airflow control" by ebm-papst. Obviously, facades are exposed to different pressures, making suction and overpressure effects possible at one and the same time. This non-sensor airflow control is programmed into the EC motor electronics, i.e. the fan measures current draw and rotational speed, which are both used for

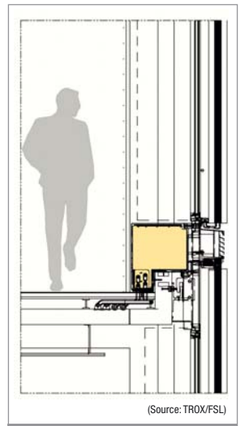


Image 4: Mounting position in the facade

“With a decentralised air-conditioning solution EC technology is especially efficient”

the calculation of airflow. Control is thus effected without pressure or flow sensor. With negative pressure, speed is increased; with excess pressure, the fan rotates more slowly, thus resulting in the proper airflow in the room at any time.

So, with a decentralised air-conditioning/ventilation solution, where many individual units are used, EC technology is especially efficient and economical. For the compact fan, even a flat scroll housing and an impeller were developed. Acoustic problems due to the compact design are minimised by sound absorbers, so no user of a room is even aware of them. The future tenants of the Laimer Würfel, the biggest of which is the DAB Bank with about 500 employees, can certainly enjoy every comfort due to the decentralised ventilation concept.

Dipl.-Ing. (FH) Andreas Salig
Project engineer Domestic Sales
ebm-papst Mulfingen GmbH & Co. KG

Module 1: Laimer Würfel – Facts and details

- Constructor: Hochtief Projektentwicklung
- Architects: Frick Krüger Nusser Plan2 GmbH
- Planners HVAC/R:
  Planning office CAE: J.Weißenhorn, H. König
- 11 upper floors
- Height 44 m
- Approx. 1,900 m² per floor
- Three underground floors
- 3 m headroom in the upper floors, approx. 6m on the ground floor
- Construction depth: 12.15 m and 13.50 m
- Two independent entrance areas, each with its own lift zone
- Four development cores
- High flexibility of floors
  (multi-functional ground floor can be separated)
- Modular design of ventilation units - 1,600 parapet units in frame housing design

Decentralised ventilation system with EC technology as new alternative:
Modern technical facility management in the Laimer Würfel

Module 2: Talking with the architect*

What is so special about the “Laimer Würfel” project?

The Laimer Würfel is an urbanistic mark in the west of Munich transcending any profiles. It is situated directly at an important hub where radial highways and arterial roads and a central railroad line meet. This place, formerly faceless, now gets a very marked profile due to the Laimer Würfel, and the urbanistically almost unimportant Laim quarter now gets a new point of reference of overriding importance and with a high recognition factor. Moreover, the Laimer Würfel is extremely efficient in terms of floor plan design. Each floor can be divided up into four independent rental units situated in interwoven L-shaped building parts. These two Ls can easily be recognised from the outside due to the different façade materials. The L facing the Laim quarter is also raised and protrudes by about 6 m at the front, which makes for a spectacular urbanistic situation.

How good is your co-operation with the constructor, the Hochtief Projektentwicklung, Munich?

Extremely positive and constructive, I would say. We deeply appreciate the fact that Hochtief Projektentwicklung stuck with the project and believed in its realisation even at times when the market for commercial property was difficult.

Was there anything special that had to be taken into account for the ventilation concept respectively for air-conditioning?

Well, one special feature is the decentralised ventilation concept adopted for the Laimer Würfel. There really is no classical air-conditioning in that sense, only the so-called climate boxes in the façade parapets, i.e. individual units cooling and heating the room air according to what is required.

How do you rate the decentralised ventilation of this building?

Well, as the building has only recently been put into operation, we do not have a lot of empirical data yet. However, we believe that this decentralised ventilation, together with the sun protection on the outside, will definitely meet all the requirements for office climatisation with summer temperatures.

*We talked to Axel Krüger, Managing Director of Frick Krüger Nusser Plan2 GmbH, Munich, and in charge of architecture and planning of the Laimer Würfel.

The fast and reliable way to the energy-saving fan

Saving energy is more important now than ever before, and measures toward this end are being implemented in a wide variety of areas. Fan technology is also seeing the effects of this trend. In this field, energy-saving EC motors are increasingly replacing conventional AC drives. Their high efficiency allows energy consumption to be reduced by up to two-thirds in many applications. The basis for replacing conventional AC technology has been provided primarily by advances in magnetic materials and electronic components, as well as optimised commutation techniques. However, new development strategies have also made an important contribution. Simulation, rapid prototyping and rapid tooling not only allow a significant reduction in development times, they also allow increased product quality and functionality.

Image 1: W1G200 axial fan with energy-saving motor

The multifaceted product range of motor and fan specialist ebm-papst Mulfingen provides countless examples of this. Typical examples are the energy-saving motors (ESM), which have been developed primarily for applications in refrigeration technology (image 1). Since refrigeration systems are operated with high duty cycles, energy savings are particularly noticeable in this area (image 2, see page 16). The energy-saving motors are used in axial fans with a diameter of 200 mm, and thus are particularly well suited to use in refrigerated and freezer cases or bottle coolers. Worldwide demand for energy-efficient systems is increasing with remarkable speed, and requirements of end customers and legal regulations provide additional incentive. In response to these market trends, ebm-papst has launched a development project to adapt the energy-saving fan to the more stringent demands of the market and generate an entire series of these fans. The new sizes 230 (image 3, see page 16), 250 and 300 mm have been added to the highly successful W1G200 model.

With their new plastic rotor, which has been optimised according to aerodynamic requirements, the fans now work even more quietly and require no varnish – a particularly environmentally friendly feature. New development strategies allowed the "time-to-market" to be drastically reduced during development. It took only one year to get from idea to perfected product, an often time-intensive journey. At the same time, during product development, adaptations could be incorporated directly into the development work at almost every stage.

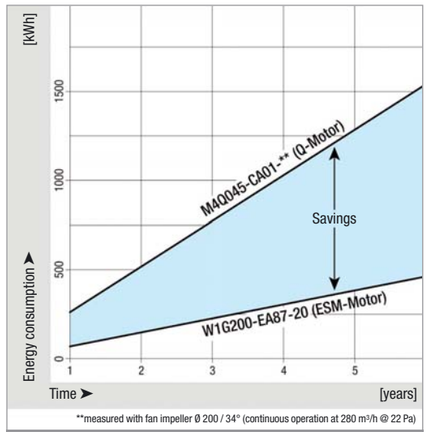


Image 2: Comparison of curves of ESM and shaded-pole motors

Optimised workflows: CAD and simulation provide a virtual fan

Fans with electronically commutated motors are complex mechatronic systems, and their operating performance is determined by the interplay of many factors. These include electronics and electrical engineering as well as aerodynamics and interactions with the user's system. Therefore, a flexible and efficient development process is possible only if all disciplines work hand-in-hand from the very beginning. For example, the installation space that will ultimately be available can then be considered at an early stage. This eliminates unpleasant surprises such as those caused by a board that is too large. This, in turn, prevents many correction loops that not only cost both time and money.

The key is the 3D CAD systems, which all ebm-papst development departments use throughout the entire process

Image 3: Series expanded with addition of W1G230 fan (exploded drawing)

Simulation, optimisation, realisation:
The fast and reliable way to the energy-saving fan

"The CAD systems are integrated into the development process to a great extent"

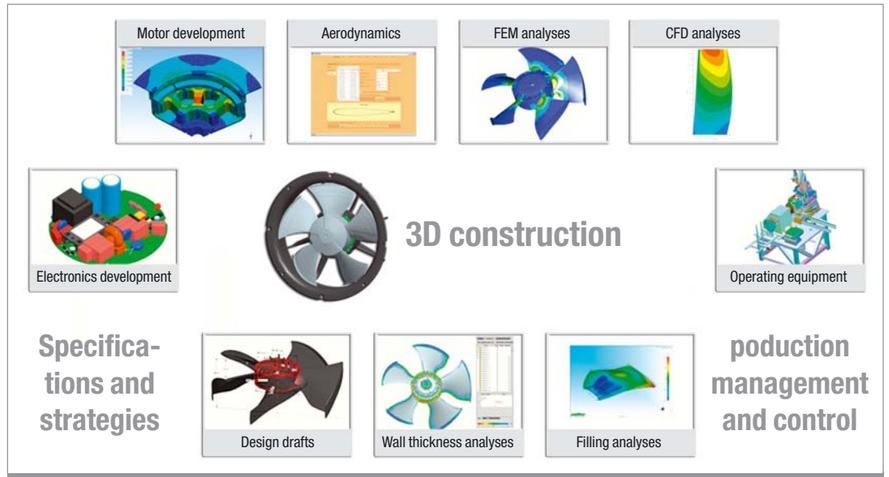


Image 4: Integration of the CAD system

chain. The CAD systems are integrated into the development process to a great extent (image 4) and include simulations not only from the design engineering area, but also from production engineering. Both the CAD system and the simulators always make use of the same data model, which is up-to-date at all times. The advantages of this method are clear:

For example, FEM calculations are possible at an early stage, the part geometry can be optimised and a material selection made. Therefore, the function of the parts can then already by simulated in realistic conditions, evaluated and optimised if necessary. Questions regarding thermal behaviour can also be answered in this context, and the developers can, for example, determine the dimension and structure of cooling elements accordingly. Thus all of the necessary assembly processes can be planned, even at this early stage; the design of the required installation equipment begins now, and even milling programs for building tools and operating equipment can be programmed using the CAD data. Because the layout data of the PCB design can also be transferred to the CAD system, it is even possible to determine exact air and creepage distances in the CAD model.

Optimising the impeller geometry

Aerodynamics is another discipline that benefits from the high integration of CAD systems and simulators. In this area, computational fluid dynamics (CFD) has proven to be an important tool for optimising impeller geometry. This numerical flow simulation is becoming increasingly important, as the sophisticated simulation options render unnecessary many of the steps that would otherwise be required during the R&D process.

Simulation, optimisation, realisation:
The fast and reliable way to the energy-saving fan

“The sophisticated simulation options render unnecessary many of the steps”

Without CFD, many cost and time-intensive experimental loops are required. Prototypes have to be built, measured in the air performance test rig, then evaluated and modified according to the trial-and-error principle until the requirements are met. Using the simulation instead provides the best possible results promptly, as it allows significantly fewer development loops. Furthermore, more variants can be analysed and evaluated, as simulations with 3D models can be made more quickly on the PC than is possible using prototyping and the corresponding measurements. The same holds true for motor development. Here, too, sophisticated software solutions save time and money, such as when optimising the electromagnetic circuit.

Rapid Prototyping and Rapid Tooling

If the simulations of all disciplines provide satisfactory results, including the interaction in the collision or installation space simulation, an important development milestone has been reached. The virtual fan is ready. Now, physical devices have to be used to verify the simulation results. To remain flexible and efficient in this phase, engineers in Mulfingen again make use of state-of-the-art technology.

After successful simulation, a prototype of the fan is created, based on the data model, in a rapid prototyping process. This means that the existing data are converted directly into moulded parts without manual intervention. Plastic parts, for example, can be built up in layers from formless or form-neutral materials using physical and chemical effects. These laser-sintered parts are available after one or two working days at most. If multiple parts are required, they can be manufactured in a vacuum pouring process. Elastomer parts can also be produced using these processes. If sheet metal or aluminium die-cast parts are required, they can be produced in five to ten working days using suitable processes. Using the EC fan manufactured in this way, many functions can be tested and evaluated realistically. Any flaws that could not be detected during the simulation phase are now visible and can be eliminated without elaborate correction loops. However, to draw final conclusions about the operating performance, mechanical resistance, and expected service life of the fans, “real” devices, consisting of the original materials and parts to be used later, are required. Still, to build series tools at this stage would be premature – after all, details can still change. Rapid tooling solves this problem.

The first small lot, which is tested under real-world operating conditions – and possibly in the application environment – can be manufactured using simple tools that differ from the later series production tools primarily in terms of materials and creation time. They can be milled from aluminium blocks, for example. Of course, the data of all previous development steps are available for the design of these parts. Smaller plastic parts can be available in as little as ten working days. Other manufacturing-specific software tools support toolmaking. For the plastic injection moulding process, the filling simulation provides information about the optimal injection point, the filling behaviour and the optimum arrangement of the mould cooling to minimise warping. The tools are likewise first computer-optimised. Once all specifications have been attained, the series production tool can be manufactured and production can begin. Thus it was possible for the new energy-saving fans to be ready for series production in the least possible time, and with significantly better product performance compared to the conventional process.

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

After a quick installation, going on one's way-without a caretaker

Those who use a wheelchair due to illness or handicap often require assistance from others to get around. This is especially true of children, older people and those who have coordination difficulties or too little strength in their arms and hands. Today's state-of-the-art technology helps to overcome this, enabling individuals to get around without assistance. The ideal drive solution for these wheelchairs is to use maintenance-free, energy-saving, electronically commutated direct current motors. Together with drive electronics and an operating device adapted to the degree of disability, this allows any wheelchair to be powered without cables. Thanks to the powerful drive motors, a retrofitted drive unit with battery pack permits ranges of up to 15 and slopes up to 20 %. It is no longer necessary to have a caretaker go along. The intelligent technology not only gives people in wheelchairs mobility, it makes them independent.

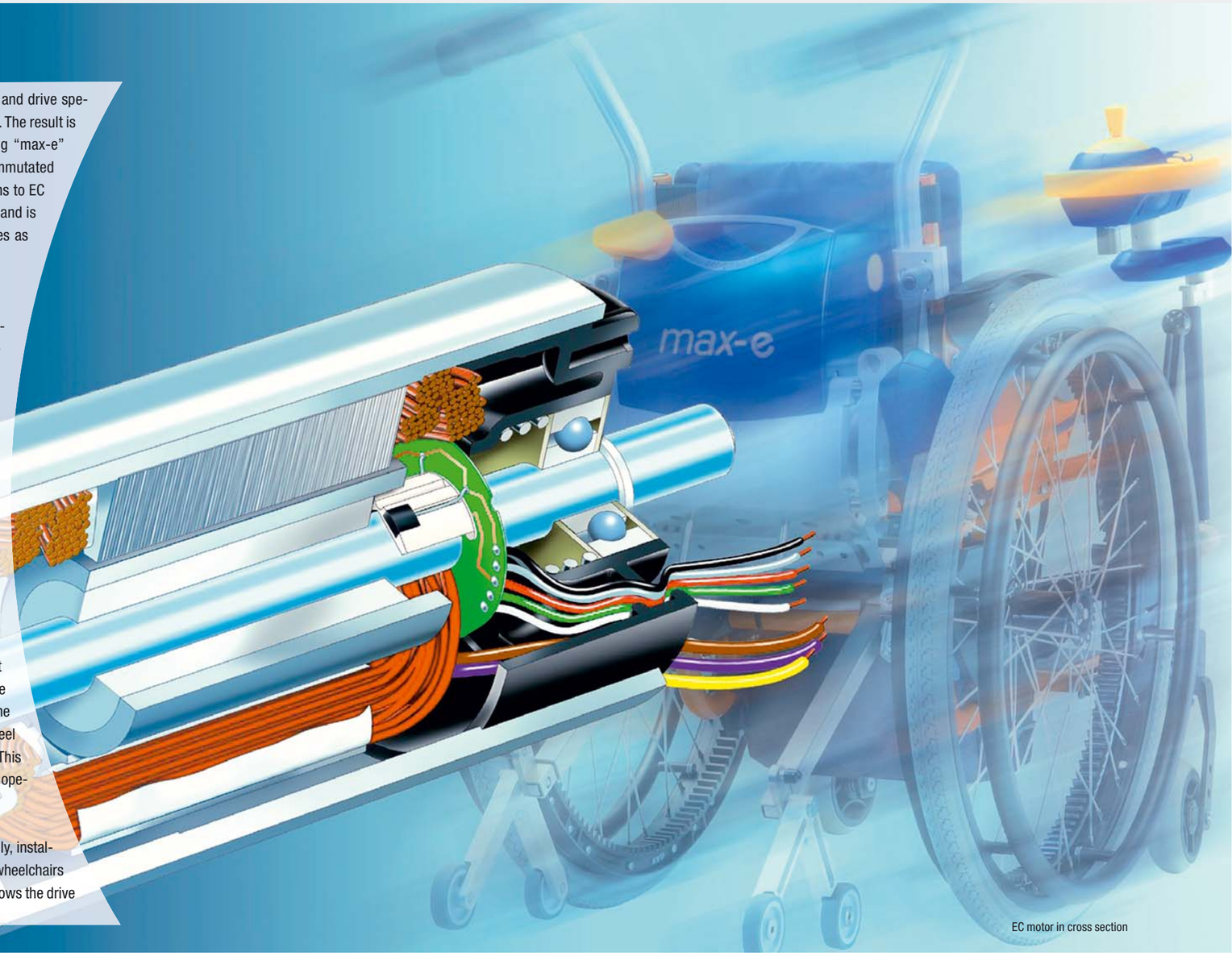
Despite great advances, as a way for people to get around, the wheelchair still is lacking in many aspects of mobility. Naturally, a person cannot do as much work with their arms as they could with their legs. When we consider that without training, a person is only capable of putting out 60 to 100 W of power on an enduring basis, any additional performance impairments quickly become burdensome when using a wheelchair. For this reason, AAT Alber, the drive specialist for transport and rehabilitation technology, has developed a new electric drive that can be retrofitted onto almost any manual wheelchair. To optimise the drive in the most professional manner possible, the company is cooperating with fan and drive specialist ebm-papst of St. Georgen, Germany. The result is the compact, powerful and energy-saving “max-e” drive, which is based on electronically commutated DC motors (EC motors). The drive conforms to EC Directive 93/42/EEC for medical products and is recognised by health insurance companies as a medical aid.

Strength in functional design

The drive itself has to meet all the requirements specific to wheelchairs. For example, vehicles with wheels on both sides normally require a differential to compensate for the difference in curve radius between the two wheels. The developers cleverly bypassed this fact by providing a separate drive motor for both the left and right wheel. Thus the electronic control system regulates the necessary wheel slip without costly mechanical components.

Instead of large curve radii like those of separate pushing or pulling aids attached in front of or behind the chair, the compact drive allows turning and maneuvering in the tightest spaces. Like the movement of the chains in a chain-driven vehicle, one wheel rotates forwards, the other backwards. This allows 360-degree turns, just as in manual operation.

So that the drive can be installed universally, installation kits are available for all common wheelchairs with a seat width of 28 cm or more. This allows the drive



EC motor in cross section

Image 1: Compact drive, as easy to switch out as the rechargeable battery pack and operating device

to be installed and removed easily. The battery pack can also be exchanged if necessary, and the operating device removed (Image 1). The operating device, which is wirelessly connected to the electronic control system, features a variety of ergonomically shaped operating levers such as softballs, golf balls, forks for tetraplegics etc., ensuring optimum control of the wheelchair at all times. With its compact dimensions and light weight, the drive unit fits on almost any manual wheelchair. Since it is installed without changing the chair's geometry, the familiar movement characteristics remain intact.

Because each motor can provide effective power of up to 90 W, slopes up to 20 % and a total weight of drive module, wheelchair and occupant of up to 200 kg are no problem. Though the drive packs 180 W of power, in normal operation, the battery capacity lasts for a total distance of about 15 km. At 6 km/h, the forward speed equals a brisk walking pace; the reverse speed is 3 km/h, and both are continuously adjustable. All parameters can be programmed via an interface. The drive itself consists of the actual motor with electromagnetic brake, a reduction, and a pneumatic engagement and disengagement system. The extendable drive shafts transmit the power from the motor to the wheel. Each drive shaft end has a drive pinion that meshes with a geared ring fastened to the wheelchair wheel (image 2). This guarantees a safe, non-slip, positive locking drive.

Maintenance-free power source

The drives used are maintenance-free internal rotor motors. Thanks to the electronic commutation, there are no mechanical wear parts other than the ball bearings of the

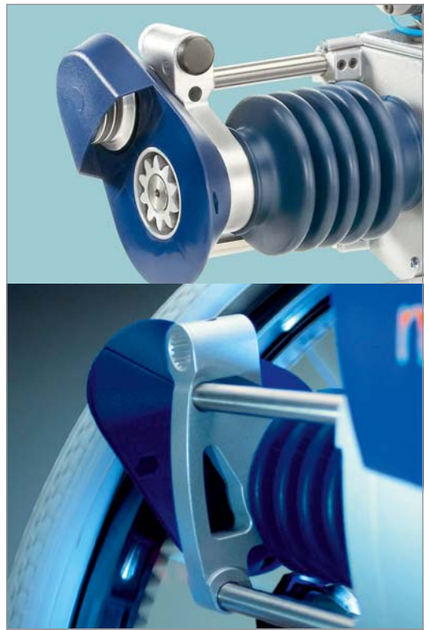


Image 2: Positive locking drive per gear improves safety and service life

Versatile wheelchair drive powered by EC-motors:
After a quick installation, going on one's way-without a caretaker

“The drive works in the optimum range and reaches high efficiency”

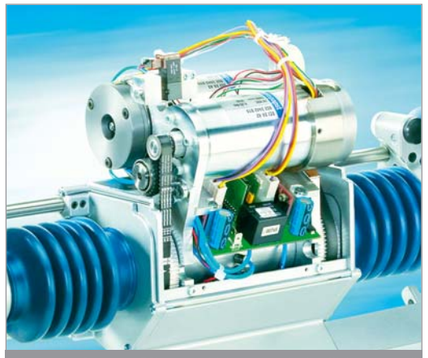


Image 3: Compact ECI motor, high output, high efficiency, small design

anchor. This allows multiple tens of thousands of operating hours to be attained with no problem. Thanks to the continuous rotary axis with outlets on both sides, the reduction and mechanical brake can be flange-mounted separately, yet in a compact manner (image 3). Despite the drives' sturdy design and high dynamics, they are quite small, with a diameter of 56 mm and a length of 103 mm. The precision ball bearings ensure minimal operating noise, and the aluminum housing provides fast heat dissipation, even at full load. At a nominal speed of 3000 rpm, the drive provides a torque of 290 mNm – more than enough to reliably conquer slopes. Three integrated Hall sensors detect the rotor position and signal it to the electronic control system, which, in turn, specifically controls the current impulses for the stator winding. Thus the drive always works in the optimum range and reaches high efficiency.

Thanks to the electronic control system, the drive can also be operated in what is known as generator mode. In this mode, the drive works like a bicycle dynamo, braking the wheel and thus generating power that be fed back to the battery. This improves the range and, more importantly, relieves the mechanical brakes during long brake operation when going downhill. Because the EC motors brake without any wear, this clever trick reduces the maintenance effort. For the same reason, modern commercial vehicles also use this type of wear-free electrical sustained-action brake. Now, thanks to the EC drive and intelligent control, they are also used for the wheelchair drive and, as a welcome side effect, improve the energy balance of the drive system.

Modern EC small drives offer previously undreamed-of possibilities. Today, the only limit is the developers' imagination, not the technology. This allows great forward leaps and innovations to be made in development, particularly for technical aids for the medical field. Close cooperation of the user and drive specialist from the early development stage on results in high-performance solutions that would have been unimaginable just a few years ago. In the case of the wheelchair drive and other related aids, this means more individual freedom for those with handicaps.

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Targeted hot spot cooling for vehicle electronics

Today's premium cars contain a large number of electronic helpers. In this area, the Mercedes S-Class has set new standards with its instrument cluster and central display for driver information. Here, all of the instrument panel's electronics are combined into two central locations. This, however, generates a concentration of emitted heat at these places in the vehicle. For smooth operation, well-designed and targeted cooling of these hot spots is necessary. Of course, particular value is placed on comfort, and thus quiet operation in the typically tough conditions of vehicle applications.

The “command system” of the new S-Class combines the central instrument display, controls and infotainment center, including the navigation system. The electronic system also includes the control electronics for various vehicle functions. All of these components give off waste heat to the surrounding area. To prevent harm to the electronics, targeted dissipation of this heat is required. To develop effective, cost-effective and reliable cooling for the electronics in the instrument panel, fan and cooling expert ebm-papst St. Georgen has contributed its specialised skills and knowledge to the development process.

Special operating conditions

It all began with the specification, which clearly listed the requirements that had to be implemented. The most important of these was efficient cooling performance with highly accurate heat dissipation at the origin. Only by ensuring this it is possible to attain temperature values that prolong the service life of the electronic components and provide high operating reliability. Equally high in priority, however, are the requirements for the operating convenience of the cooling and easy retrofitting of additional components or device functions. To meet these requirements, the specific operating conditions of vehicle applications have to be considered, in addition to the purely aerodynamic aspects.

For example, the temperature span for vehicle components ranges from -40 °C to +85 °C, and electromagnetic compatibility plays an important role with such highly concentrated electronics. No less important is the requirement for the electrical and electronic systems to be tolerant to fluctuating supply voltage and possible voltage peaks. It is a matter of course that the mechanics have to be adapted to the design of the individual vehicle. Moreover, all components have to withstand vibrations and shock during vehicle operation without failing. Maintenance-free performance over the entire service life is another important point, and has to be guaranteed despite the stringent requirements of the location of use.

Intelligent solution for air conduction

With all of this in mind, ebm-papst, the fan expert from Germany's Black Forest region, developed a cooling system together with automakers that is ideally suited to electronics cooling. Heat dissipation primarily means introducing colder air and conveying it to the hot places in a targeted manner. The coldest place in a car is always the footwell,

Image 1: The air conduction and cooling system as a complete module

“The centrifugal fan with cylindrical rotor is especially compact”

so this was an obvious location for air intake. Because the components of the display unit are roughly divided into two smaller areas, the cooling air conduction had to be designed accordingly. This brought about an air duct in the form of a complex air conduction system (image 1, see page 25).

The instrument cluster requires approximately 7.5 m³/h or roughly 60 % of the cooling air, while the central display makes do with 5 m³/h or about 40 %. At first glance, the rough shape of the ducts is already predefined by the component arrangement in the instrument panel. Despite this, the ducts have to be resized according to their tasks to ensure uniform system counterpressure that is as low as possible. Designing the aerodynamics skillfully made it possible to minimise air turbulence in the duct. Unimpaired flow can be attained only by eliminating all abrupt changes of cross-section, constrictions, dead spaces and recesses. This lowers the operating noise level, increases the air flow and thus facilitates later retrofitting of additional components that require cooling. Based on a duct that completely utilises the available space, a simulation program calculates the optimum design within these maximum limits (image 2).

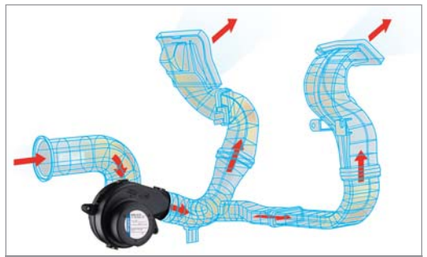
Image 2: Optimising the air ducts using a flow simulation

Before and during the simulation, the actual air flow values measured in the air flow laboratory in duct models are entered into the calculation program. This results in an evolution of the optimum form. The central part of the air conduction system with the fan motor is installed on rubber anti-vibration mounts, known as silent blocks. Additional foam pads and foam duct sections in the air conduction system decouple the rigid plastic parts and effectively prevent structure-borne noise in the components.

Quiet fan

Of course, the central part of the electronics cooling is the fan itself. Here, the fan experts at ebm-papst were able to make use of a platform centrifugal fan that had been tried and tested in automotive applications, specifically modifying it to the operating conditions. Sensorless motor electronics were used, for example, which are highly resistant to electromagnetic interference (EMI). Particularly quiet and EMI-resistant commutation lowers both the acoustic and electrical emissions of the fan (image 3). Thus there is neither operating noise to disturb passengers nor interfere with the vehicle's electronic systems.

The ball bearings are lubricated for life, adapted to the fluctuating ambient conditions such as humidity and temperature. This, along with the wear-free brushless motor commutation, allows the fan motor to reach operating times up to tens of thousands of hours. This means that it is designed for lifetime use and never needs maintenance in normal operation of the vehicle. Easy startup is guaranteed, even after long idle periods. Of course, the quietest fan is one that is not moving. Accordingly, the intelligent control system starts the cooling fan only when truly necessary. The active cooling is activated only when the critical electronic components reach an operating temperature over 65 °C. A positive side effect is the energy savings, decreasing the load on the vehicle electrical system.


Image 3: Specifically modified fan motor from the standard product line shortened the development time

Due to both the decentralised arrangement of the fan and the conduction of cooling air over long air ducts with many corners, selecting the right fan is critical. To ensure that the cooling system functions properly, the fans must work reliably, even under such harsh conditions. For example, a critical factor for efficient cooling of the instrument cluster in the S-Class is the ability of the fan to build up sufficient pressure for transporting air through the long cooling ducts. Centrifugal fans offer several advantages for these working conditions. They can transmit more energy to the air flow due to their design. Because the flow always exits the impeller along its outer circumference, where circumferential speeds are greater, it has a higher pressure level. If higher pressure and lower air flow are required, as is the case here, this is the right fan. Precisely for this application, centrifugal fans offer an additional structural advantage that comes to bear when installation conditions are extremely tight: they deflect the air flow direction by 90 degrees. The air is sucked in axially and blown out radially. Because of the way the system operates, centrifugal compact fans are highly suited for being adapted to air ducts. This means that the fan does not necessarily have to blow directly onto the components that need to be cooled. Instead, the designers are able to position it almost anywhere under the instrument panel. Due to the exceptionally tight installation conditions in vehicles, ebm-papst uses a special variant, known as a centrifugal fan with cylindrical rotor (image 4). For this type of fan, the impeller has many short, forward-curved blades, making it especially compact. This design allows the fan to have relatively small dimensions with a high pressure output.


Image 4: Centrifugal blower with cylindrical rotor

Turning electronics cooling into a complete supplier module defined a new standard. Because fan expert ebm-papst draws on many years of skill and knowledge in cooling air conduction, it was able to perfectly implement vehicle-specific design and optimum aerodynamics of the air ducts. This keeps all critical components cool, even where the power density of the electronics is high.

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Complex supplier part controls climate of “data center” in cars:
Targeted hot spot cooling for vehicle electronics

New gas blower for condensing boiler technology – quiet and efficient

Modern compact gas heaters are based on the principle of condensing boiler technology. They are known for their good energy utilisation and compact dimensions. While condensing boilers once were more common in the lower power range, systems with up to 120 kW now exist as wall units which, due to the space conditions, require power-optimised, compact fans. A newly developed gas blower with optional integrated venturi mixer for heat output up to 150 kW is a response to this trend.

The new blower can provide a performance increase of up to 20 %

Compact condensing boiler systems are often installed close to the consumer. Naturally, this proximity makes noise emissions especially bothersome. For this reason, motor and fan specialist ebm-papst Landshut has had a new, compact gas blower family with minimum operating noise on the market since 2006. Now, the product range is being expanded up to 150 kW with the new NRG137 fan (image 1). All of the main dimensions and flange dimensions have been taken over from the predecessor model RG148, making replacement for increased power or efficiency easy. Efficiency in heating is a combination of several different aspects. One, of course, is the efficiency of the heater itself – optimum fuel utilisation. However, the space requirements – the power density of the heating system – are likewise important. Factors such as noise emission and low electrical input capacity also play a role. The new gas condensing boilers with the new NRG137 have been designed with these requirements in mind.

Image 1: New gas blower NRG137

Optimised aerodynamics

Perfect aerodynamics is the specialty of the Landshut-based manufacturer. Therefore, the new blower includes a few aerodynamic improvements that allow it to attain the same performance data as the predecessor model RG148 at lower speeds. The new blower can provide a performance increase of up to 20 % (image 2, see page 31). A particularly useful feature is the optional integration of the venturi mixing nozzle into the blower (image 3, see page 30). Instead of building the mixer from several different parts and retrofitting it on the fan, users now can cover the entire desired power range with a single, flow-optimised injection-moulded insert. This

Product family expands upwards:
New gas blower for condensing boiler technology – quiet and efficient

Image 3: Integration of the venturi mixing nozzle into the gas blower

saves costs and improves the effectiveness of the heating system.

Compact technology

The aerodynamically optimised fan can be used for significantly higher heating capacities and thus also requires a higher drive output. To achieve this goal, the motor technology underwent a major overhaul. The manufacturer attains the added output with the predecessor type's tried and true electronically commutated motor. However, the critical break from the past is the new, microprocessor-controlled drive electronics. They not only substantially improve the power output, they also reduce motor noise. As a result, the new condensing blower runs significantly faster than the predecessor model, although the rated output is up to 20 % higher. The supply voltage is 120 VAC or 230 VAC and thus is also suitable for worldwide use.

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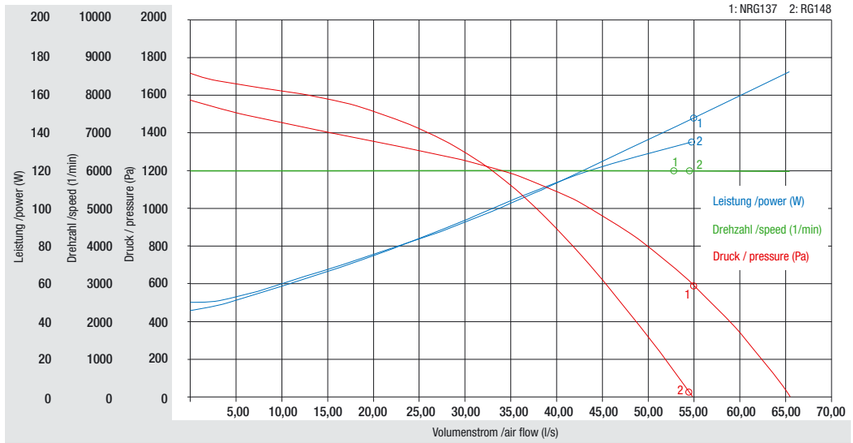

Image 2: Comparison diagram – NRG137 to RG148