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NEW IDEAS AT A GLANCE

The engineer's choice

ebmpapst

Editorial

“The right product for every application”

Dear customers, partners and friends of ebm-papst,

“Euro crisis”, “burden of debt”, “regressive growth”, “energy transformation” – right now there are more than enough reasons for uncertain markets. But we’d rather concentrate on certainties. This is why, with the ErP Directive, the EU has made an important contribution toward reducing energy consumption and, at the same time, achieving climate goals along the way.

The first stage will come into force at the beginning of next year. Many manufacturers therefore have an urgent need to take action by replacing products that are in use, yet no longer meet the standards, with high-efficiency solutions. Our experience in this shows that the consulting effort is enormous and the dialogue with our customers is the key to success.

For quite some time, we have already been approaching this process with our GreenTech philosophy and therefore have the right skills and knowledge, not to mention the right products. We will again demonstrate this at this year’s Chillventa trade fair, the leading trade fair in the refrigeration segment. One highlight to be presented is our latest development, the AxiTop diffuser, which in air-cooled heat exchanger applications drastically reduces, yet again, noise and energy consumption. This innovative solution requires no redesign of the customer’s application and can even be retrofitted with ease into existing systems. This leads to a whole new dimension for additional application optimisation. Likewise, we continue to keep the AC2EC philosophy in our focus so as to replace existing AC fans with efficient GreenTech EC fans. For this purpose, we have further expanded our range of products to include “the little HyBlade®” axial fans for evaporators in extremely energy-efficient designs – as a user-friendly plug-and-play solution, of course. We are well positioned in this, with perfectly suited products for every application. I look forward to seeing you in October at the Chillventa trade fair in Nuremberg and to present these latest innovations to you in person.

We also want to spread the GreenTech philosophy into additional markets. In the process cooling segment, there is also catching up to do, just as in the ever-more important “Green IT” market. Among data centre operators, there is increasing certainty that forward-looking hardware cooling technology inherently belongs to a forward-looking information technology field. Ideal solutions to this are our new “big guys”: an EC axial fan with a size of 1250 mm and our EC plug fans in sizes 630 to 910 mm. We also strive to be a highly competent partner in this. For the upgrade to GreenTech is not purely a question of conscience, but rather provides, along with lower consumption, enormous potential to cut costs quickly and sustainably.

While reading this edition, you will learn how we, working with our customers, implement this in concrete applications. I hope you enjoy it!

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Refrigeration & Industrial Engineering
ebm-papst Mulfingen GmbH & Co. KG

Content

Page:




Prize-winning low-energy housing complex in Switzerland

Fig. 1: Solar City in Satigny, a social housing project, won the 2011 Swiss Solar Prize in the category C “Energy Systems for Renewable Energies”.

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Last year, the Solar City housing complex in the wine-growing region of Satigny was awarded the Swiss Solar Prize 2011 in the category “Energy Systems for Renewable Energies” for its eco-friendly energy and heat generation. 80 % of the energy needed is generated by the complex’s own solar system. An important basis for the efficient us of regenerative primary energy is provided by the modern air-conditioning equipment employed for ventilating and heating the complex. When the windows are closed, it provides for a requirement-orientated air exchange and optimum air conditioning. The high-performance and yet energy-efficient fans with GreenTech EC technology supplied by ebm-papst which are employed in the HVAC systems make a major contribution to this.

“The thermal solar system is able to generate 80 % of the total heat energy required”

The Solar City complex (see Fig. 1), which was completed in 2010, consists of four large buildings containing a total of 78 housing units and a large underground garage on two floors. The joint project between the company ERTE Ingénieurs Conseils SA from Geneva and the vintner family Bonnet from Satigny was constructed to the Minergie S standard. Minergie is the highest energy standard in Switzerland for low-energy housing and is roughly comparable with the German standards for energy-saving houses KW40 (for new buildings) and KW60 (for refurbishing older buildings).

With the power of the sun against frost

As the name suggests, the Solar City social housing project relies heavily on the power of the sun. Around 1,160 m² of unglazed, walkable solar collectors have been fitted to the roofs of the residential buildings (see Fig. 2). These have been designed so that they are still able to generate energy when conditions are less than optimal, even when it is raining, snowing or in moonlight. That enables the thermal solar system to generate some 80 % of the total heat energy required. Green electricity from the grid accounts for the remaining 20 %. Solar City employs an ingenious combination of direct hot water generation and heat pumps without additional expensive seasonal reservoirs or geothermal energy generation with underground probes. This was an important argument for the nomination for the Solar Prize.

The efficiency of the concept has now been proven in practice. At the start of 2012, during the almost Siberian cold spell, it was really put to the test. With temperatures averaging -11 °C and 15 cm of snow on the solar collectors, it was still able to heat

Fig. 2: Around 1,160 m² of unglazed, walkable solar collectors have been fitted to the roofs of the residential buildings. These have been designed to generate energy even in unfavourable conditions (photo: Bösch).

the complex without difficulty. The 55 °C required in the boilers was achieved. The temperatures inside the apartments was a comfortable 21 to 22 °C. The residents had ample supplies of hot tap water. The additional electric heating elements which had been installed in the boilers for use in worst-case conditions were not employed even once. Despite the frosty temperatures outside, none of the residents had to freeze.

“The heat regeneration system guarantees an optimal re-use of the heat in the exhaust air.”

Ventilation concept saves energy and enhances living comfort

Such an energy concept cannot work without controlled living room ventilation. A partially centralised system was chosen for the ventilation and air conditioning of the apartments. Here, the four buildings were split into ten sections, all of which are identical in their construction, and supply up to eight housing units. Each section comprises a unit for controlled living room ventilation and heating, a heat pump and a separate hot water reservoir. The energy consumption is individually recorded for each housing unit. The recorded operating data for the complete complex are sent by internet to the University of Fribourg for evaluation.

The centrally installed RLT units of the type Optima ME, supplied by the company Bösch (see box text page 9) are responsible for a comfortable living climate in each section. These were designed specially to comply with the Minergie standard. The new line of units (see Fig. 3) with air performance of 400 to 7,000 m³/h are compliant with the latest findings in the field of energy and hygiene, and satisfy all relevant standards which are applicable today for minimum energy equipment. The design of the air conditioning equipment plays a decisive role here.

Energy-efficient centrifugal fans

Large-area, humidity-resistant fine dust filters made out of pleated glass fibre material of class F7 pursuant to EN 779 with a protection rating of more than 60 % provide for a high level of air cleanliness and guarantee a healthy room climate even when the outside air is polluted with fine particulate matter. The ultra-efficient heat regeneration system (the residual heat coefficient ϕ is greater than 80 %) guarantees an optimal re-use of the heat in the exhaust air. The heating of the fresh air, which is needed at very low outside air temperatures, is achieved with a PWW (pump/warm water) register from the heat pump. To generate the necessary ventilation and air

Fig. 3: The RLT units of the type Optima ME from the company Bösch are compliant with the latest findings in the field of energy and hygiene, and satisfy all relevant standards which are applicable today for minimum energy equipment (photo: Bösch).

Energy-efficient air-conditioning technology with modern GreenTech EC fans:
Prize-winning low-energy housing complex in Switzerland

“The optimum fan solution can be found for every air-conditioning unit”

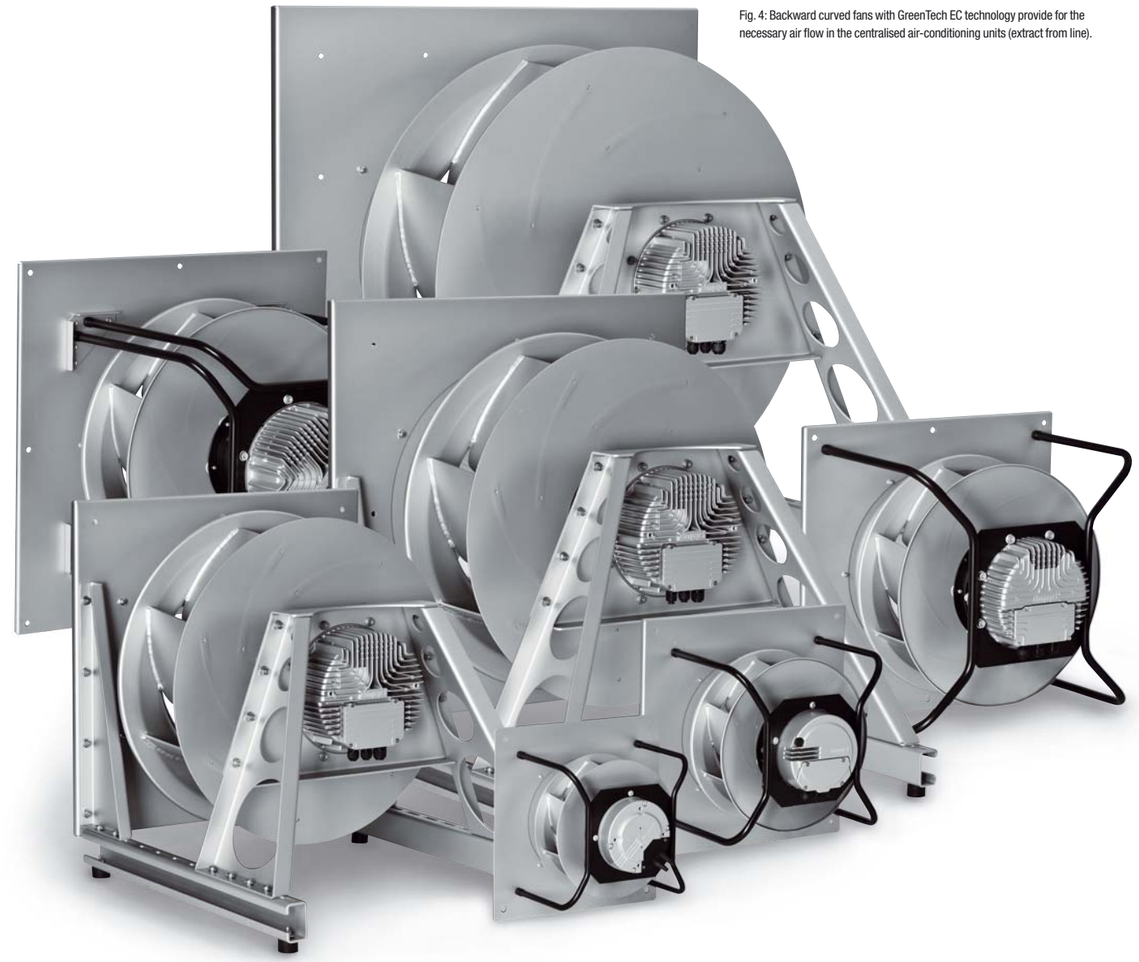

Fig. 4: Backward curved fans with GreenTech EC technology provide for the necessary air flow in the centralised air-conditioning units (extract from line).

Energy-efficient air-conditioning technology with modern GreenTech EC fans:
Prize-winning low-energy housing complex in Switzerland

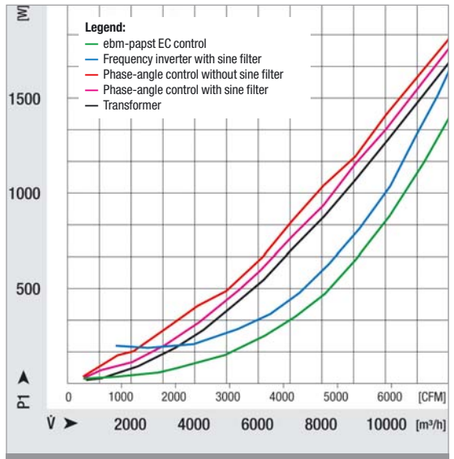

Fig. 5: Because the EC motors work so efficiently, they consume substantially less energy that conventional AC drives.

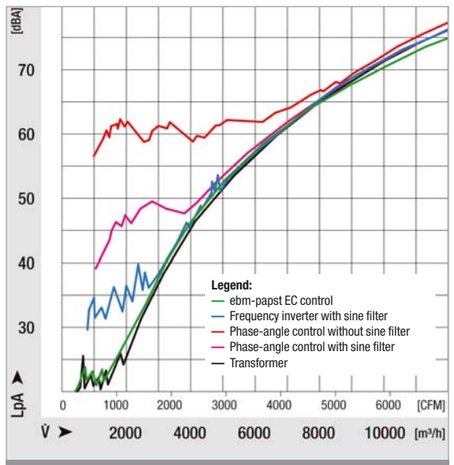

Fig. 6: Noise emissions of AC and EC motors in comparison.

extraction flow, two centrifugal fans are used in each of the units. These are highly energy-efficient and are regulated extremely economically (see Fig. 4, page 7). They are taken from the product range of motor and fan specialist ebm-papst and are specially designed for use in ventilation and air-conditioning technology. Different versions ensure that the optimum fan solution can be found for every air-conditioning unit. For example, in the central air-conditioning systems in Solar City, Bösch employs centrifugal fans of size K3G280 with backward curved blades. These fans work chiefly by suction, do not require a scroll housing and have a high level of hydraulic efficiency. Furthermore, the GreenTech EC technology also means a whole lot more other advantages.

Freely adjustable controls and pleasantly quiet

The EC motors that power the fans feature an integrated electronic control system that allows the speed of the fan to be adapted precisely to what is actually required. Requirement-orientated operation can be controlled either with an analogue 0...10 V signal or via a digital RS485 interface. Because the motors also work with great efficiency, they consume substantially less energy that conventional AC drives (see Fig. 5), not just at full load but also in part-load operation. At the same time, they create practically no motor noise (see Fig. 6). In contrast, asynchronous motors driven by a frequency inverter, particularly under partial load, produce resonance noise that results in the typical unpleasant motor hum. This would certainly not provide a pleasant living environment. The residents of Solar City have nothing to fear. The air-conditioning units are equipped with fans powered by pleasantly quiet GreenTech EC technology. These are practically inaudible in the apartments and on the stairs.

Another advantage of these fans is their compact design. The electronically commutated external rotor motor is directly integrated into the impeller, which reduces the installation dimensions. A belt drive between the motor and the fan, which is commonly used otherwise, is not necessary. This reduces not only the required installation volume – always desirable for the air-conditioning units made by Bösch – but also the associated installation complexity. At the same time, fewer parts are required which are subject to wear. This keeps service costs low over the long term and thus saves money for the operator. Moreover, the design of the fans permits hygienic maintenance.

Ing. Thorsten Hartl
Sales Manager Austria
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About Walter Bösch GmbH

Walter Bösch GmbH & Co KG is based at Lustenau in the Austrian state of Vorarlberg and has been in existence for more than 80 years. Started as a one-man operation, the company has grown into a medium-size organisation with around 650 employee. It is one of Austria's leading companies in the fields of heating, air-conditioning and cleaning technology. Its air conditioning and ventilation systems are custom-built to cover the dehumidification and ventilation requirements of a small hotel bathroom or the air conditioning requirements of industrial production halls and clean rooms. They can be installed in the basement or weatherproof versions can be fitted on the roof. Intelligent control solutions and complete systems with integrated heating and hot-water production bear witness to the synergies between the different company divisions.

One world – many climate zones – one fan

© SMA Solar Technology AG

State-of-the-art technology is used today worldwide in all climate zones. This often results in a wide variety of variants for the manufacturers, since the specific on-site conditions often require major changes to components. That increases the effort both from a design standpoint as well as logistically, and with these the production and operating costs. For the active cooling of electronic components there is now a genuine "world fan". It withstands the most extreme temperatures and weather conditions, which can occur in outdoor use worldwide. By doing so, it covers all possible applications and thereby increases the value creation for system manufacturers and users.

"The world fan withstands the most extreme temperatures and weather conditions"

The earth's climate zones serve up temperatures ranging from far below -30 °C at the poles to an average of over +33 °C at the equator. Then in addition to this are the local extremes, such as desert areas with even higher daytime temperatures at lowest humidity or the tropics with high temperatures and air 100 % saturated with water vapour. The manufacturer can enclose systems that rely on active heat dissipation by means of cooling air, if necessary. But the actually active part, the fan, always has to work "in the open" to move ambient air to the intended cooling surfaces. This is where the fan expert ebm-papst from St. Georgen comes in. The specialists from Germany's Black Forest region developed a fan (Figure 1) which reliably performs its duty under all climatic conditions and therefore is ideally suited for cooling systems in worldwide use.

Globalisation of technology

In the economy and politics in general, globalisation is the foremost modern buzzword. Technicians have been acquainted much longer with "globalisation" and above all its specific requirements for devices to function reliably all over the world. From time immemorial, therefore, the "technical" equipment for polar regions has been different than for caravans in the desert. In modern times, the problem has been solved for many years by specific adaptations of the products depending on the target region. This approach, however, is less than optimal for two reasons. For one, the logistics equipment, stock-keeping and maintenance expertise usually to be kept ready for a wide variety of special components. For another, once defined, a component selection severely limits the ability to react to market changes, in other words, a new target region. Even if systems are used at other locations, for example in the case of a resale or move, such as relocating production to other regions, costly compromises may have


Fig. 1: The new "world fan" for universal outdoor use

Whether in an icy or sandy desert, in the tropics or at the equator – cooling is always required:
One world – many climate zones – one fan

to be made. For this reason, components which can be used universally and ensure flexible manufacturing for a minimum cost outlay lend themselves as a solution today. This innovation is particularly advantageous in the case of fans for waste heat management (see Fig. 2). A fan which is used, for example, in telecommunication modules, has to work reliably under difficult conditions worldwide. Solutions for individual cases are possible, but, for reasons that are easy to see, not economical.

“The fan satisfies the strict requirements of protection rating IP68 and IP65”

Fan technology for all climates

With dimensions measuring 60 x 60 x 25 mm, ebm-papst’s 630 axial fan series has been designed so that even extreme environmental demands do not impair function. Thus construction of the electronically commutated external rotor fan is based on a stator pack that is completely coated in plastic (see Fig. 3). The integrated operating electronics are completely encased and the cable connection is specially sealed. That means the fan satisfies the strict requirements of protection rating IP68 (immersion beyond 1 m) and IP65 (powerful water jets). The potting has the additional advantage of very high corrosion resistance for the components protected by this. Thus a salt spray test with fan running for 30 days is easily passed. The motor’s high efficiency in conjunction with low lost heat, thus minimum intrinsic heating, prevents salt crystals from depositing in the air gap and extends the service life of all electronics and bearing components. Thus the fans do not heat up additionally and the thrifty power consumption makes them ideally suited for use in systems which can be supplied only by battery or solar panel.

Fig. 2: Universal fan for all climate zones.

Fig. 3: Potted interior of the fan, stator and electronics are encapsulated in plastic.

Fig. 4: Compact solar inverter with integrated fan for long service life.

As the IP68 type of protection already indicates, the fans are fully tropicalised; long-term tests with a relative humidity of over 85 % at 85 °C confirm this impressively. The application area of the robust air mover is proven in the temperature change test from - 40 °C to + 85 °C. The number of cycles here corresponds to a service life of approximately 20 years with the corresponding fluctuations for day/night and season. The electronics correspond to the highest EMC compatibility requirements and, like the robust bearing, are immune to vibrations.

For everything, everywhere

The small energy-saving fans are therefore suited for all difficult operating conditions. High and low temperatures, such as occur in solar inverters (see Fig. 4) or telecommunication modules on roofs and poles, pose no problems for them. Salty sea air or the finest desert dust impair the function just as little. In an industrial environment, where the “climate changes” from production conditions can turn out to be even more dramatic than in nature, the fans likewise stand their ground. That makes them suitable also for switch cabinet ventilation, residual heat dissipation in power inverters, robots, welding inverters and other equipment operating in a harsh environment. In the case of large installations, which often require a wide variety of fans for very different purposes, the increased reliability is important even after failures with excessive temperature or dust accumulation or the like.

Accordingly, small, robust fans which are also able to withstand the adverse conditions of outdoor use are suitable for a wide variety of applications. Thus they are suitable for worldwide use in all climate zones as well as operation under difficult ambient conditions in industry. Compared to specifically sought-out fan solutions, the use of universal fans significantly reduces production costs and substantially improves the benefit for the user. This is an advantage not to be underestimated in today’s globalised world.

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Safety for systems with natural refrigerants

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For environmental reasons, the trend today is moving towards natural refrigerants. Two categories are worth considering: non-combustible refrigerants such as CO_2 and combustible refrigerants such as propane or butane. With non-combustible natural refrigerants, the choice of fan is simple, because no special protective measures need to be taken into account. For reasons of energy efficiency, EC fans are increasingly being used here. The choice of fans when combustible refrigerants are employed is much more difficult. In this case, explosion protection measures have to be taken into account from a certain size upwards. However, that is no longer a problem. The energy-efficient properties of the EC fan, both at full load and in part-load operation, mean that it can now also be used in potentially explosive atmospheres in zones 1 and 2. Combined with the natural refrigerant, this creates a coherent combination in the interest of minimising impact on the environment.

“For reasons of energy efficiency, GreenTech EC fans are increasingly being used”

Under unfavourable conditions, an explosive mixture could be formed together with the ambient air when combustible natural refrigerants escape. Within the ignition window, which is specific to the material in question, an ignition source could trigger an explosion. The degree of risk is evaluated quite differently according to the application. For example, the degree of risk for a household refrigerator can be neglected as the volume of refrigerant is comparatively low. Any escaping gas will quickly evaporate. The situation with larger refrigeration and air-conditioning systems is different. The more refrigerant a system contains, the greater the risk will be.

Risk assessment by the employer

If the filling capacity of a refrigeration system with natural combustible refrigerant exceeds 150 grams, then explosion protection specifications have to be observed, which could have an effect on the fans used. This is regulated in Directive 99/92/EC, better known as ATEX 137. For example, every supermarket manager has to scrutinise this work protection directive if he uses a refrigeration system with combustible natural refrigerants. The directive obliges every employer operating a system with explosive elements to provide adequate protection for the persons concerned. To this end the directive stipulates that he is required to take technical and organisational measures which firstly prevent explosions from happening and secondly provide protection in the event of an explosion. In this context, he has to assess the risk of explosion and make sure that work in the company is not endangered. According to the risk assessment, the areas which may be subject to an potentially explosive atmospheres being created are to be divided into zones (see Fig. 1).

Zone ATEX 137	Duration of presence of a potentially explosive gaseous atmosphere	Degree of safety	Category (ATEX 95)	Fault tolerance
0	Permanent, lasting, frequent	Very high	1	2 independent faults
1	Occasional	High	2	1 fault
2	rare, brief	Normal	3	Normal operation

Fig. 1: In accordance with the zone classification of ATEX 137, the unit in use must be designed in line with ATEX 95 (Directive 95/9/EC).

A device may only be used in a zone if it satisfies the specifications for the relevant category. These categories are defined in ATEX 95 (Directive 95/9/EC), the so-called equipment properties directive. The zone classification is defined primarily by the frequency with which a potentially explosive atmosphere is to be expected.

If in doubt, err on the safe side

“ebm-papst has developed an energy-efficient GreenTech EC motor for use in zones 1 and 2”

In the case of refrigeration systems zone 0, where there is a permanent to frequent risk of a potentially explosive atmosphere occurring, is unlikely to be needed. In this case, a refrigeration system would from the very beginning not be suitable for the purpose. Zone 0 is, for example, the inside of a tank where explosive materials such as petrol or oils are stored. The evaluation of a refrigeration or air conditioning system will consequently be between zones 1 and 2. In his assessment, the employer thus has to decide whether a potentially explosive atmosphere is expected to occur occasionally (zone 1) or rarely and briefly (zone 2). This decision is not always easy to make in all individual cases. Certified offices may be consulted in case of doubt.

Regardless of how the decision if finally taken, today’s manufacturers of refrigeration systems are no longer reliant on the asynchronous motors approved for use in zones 1 and 2 which have been available on the market to date. Asynchronous motors may be reliable and robust, but they are energy-intensive with comparably poor efficiency. In addition, the frequency inverter needed to control the speed has to be fitted outside the potentially explosive zone and connected to the fan drive with screened wires. This is an area with great savings potential.

The motor and fan specialist ebm-papst Mulfingen has developed an energy-efficient GreenTech EC motor for use in zones 1 and 2. The performance data of the motor permit use in axial fans with diameters from 630 to 990 mm and in centrifugal fans of size 400 to 710 mm. That means a “tailor-made” GreenTech EC fan solution can be found for practically every feasible application in the field of refrigeration and air-conditioning systems. The explosion protection classification of the new EC motor (see box text) demonstrates that fans equipped with this technology are also suitable for other potentially explosive areas, for example for ventilating zone 1 areas in which petrol vapours are occasionally to be expected.

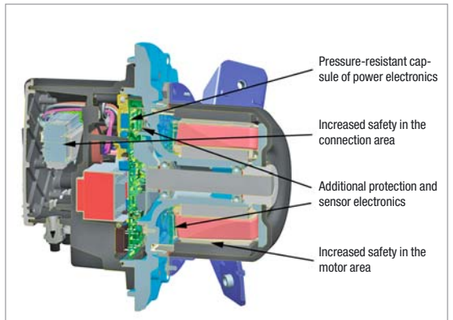

Fig. 2: Sectional image of the explosion protection version of the external rotor motor.

GreenTech EC fans for potentially explosive atmospheres in zones 1 and 2:
Safety for systems with natural refrigerants

“GreenTech EC fan solution can be found for practically every feasible application”

Explosion protection, integrated electronics and external rotor design

Like on standard motors in GreenTech EC technology from ebm-papst, the power electronics of the explosion protection variant are completely integrated into the motor. In addition, there is a whole series of explosion-relevant protection measures (see Fig. 2). For example, the power electronics are encased in a pressure-resistant capsule and both the motor and the connections satisfy the requirements of ignition protection category e (enhanced safety). The motor is designed as an external rotor motor, which is beneficial for fans as both axial blades and centrifugal impellers can be secured directly to the turning rotor, i.e. directly to the “housing” of the motor. Compact dimensions, especially in an axial direction, are the consequence and cooling is made simpler as the motor can make use of the air displaced by the fan for cooling purposes. In addition, the large air gap means a high degree of flooding in the motor, even when hard ferrites are used. There is no reliance on rare earth magnets like there is with internal rotor motors. Otherwise, the explosion protection GreenTech EC motor has the same properties as the other GreenTech EC motors from the ebm-papst product range. The electric interface provides two analogue inputs (0 ... 10 V or 4 ... 20 mA), one 0 ... 10 V output for the speed signal and one power supply of +10 V and +24 V. It is thus possible, for example, to build a condenser pressure regulator in a potentially explosive area with just one external pressure sensor (see Fig. 3). An additional motor protection switch, for example, is not needed. Of course, the materials employed for the fan blades or impellers also have to satisfy the explosion protection requirements. Fig. 4 (page 18) shows the design of a complete axial fan approved for use in potentially explosive zones 1 and 2. The

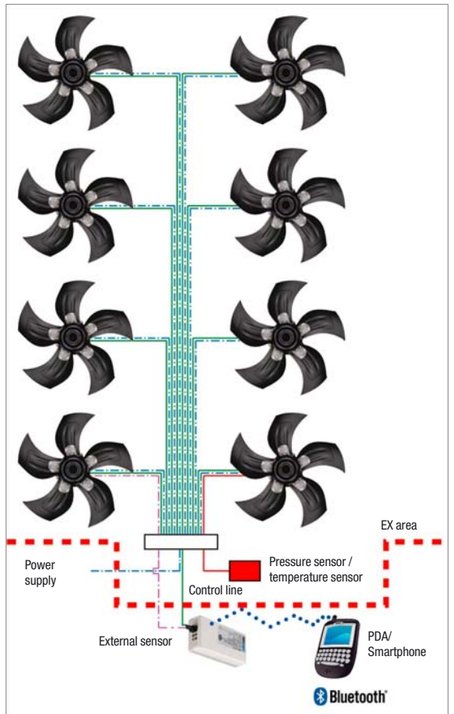

Fig. 3: Schematic of a condenser pressure regulator in a potentially explosive area.

GreenTech EC fans for potentially explosive atmospheres in zones 1 and 2:
Safety for systems with natural refrigerants

“ebm-papst sets new standards in using its GreenTech philosophy in demanding, potentially explosive areas”

Fig. 4: Axial fan for use in potentially explosive areas (wall ring made of sheet metal, HyBlade® blades made of special plastic).

wall ring, which is made out of sheet metal, together with the HyBlade® blades, which are made out of a special high-performance plastic, form a non-igniting material combination.

A coherent concept for environmental protection

Employing such GreenTech EC fans will enable refrigeration systems working with natural refrigerants to form a coherent overall concept as the energy-efficient and thus eco-friendly properties of the fan complement the equally eco-friendly properties of the refrigerant. The possible application temperature range of -40 °C to +60 °C permits condenser and evaporator applications to be equipped with axial fans, and air extraction systems, for example, with centrifugal fans. ebm-papst is thus now using its GreenTech philosophy to set new standards in demanding, potentially explosive areas. The explosion protection fans are in series production and approval certificates issued by a named office are available for the products and for production. That means that axial fans which are approved for potentially explosive zones 1 and 2 can also be used in other applications, e.g. in chemical processes.

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What does “II 2 G Ex d e ib IIB T3 Gb” mean?

“II 2 G Ex d e ib IIB T3 Gb” is the explosion protection classification of the GreenTech EC motor developed by ebm-papst Mulfingen and approved for use in zones 1 and 2. Exactly what the different abbreviations stand for is easily explained. “II” stands for non-mining application; “2” shows the ATEX 95 category and the “G” means that the motor is approved for applications with gaseous media. The ignition protection categories used are expressed by the letters d, e and ib. The additional identifier IIB T3 describes the possible gases in which the fan may be employed, and temperature class T defines the maximum permissible surface temperature (see Fig. 6). Finally, Gb stands for the equipment protection level.

II **2** **G** **Ex** **de ib** (Fig. 5) **IIB T3** (Fig. 6) **Gb**

- **G**: Gas
- **2**: Category 2
- **II**: Non-mining application

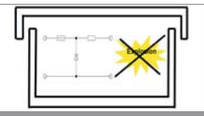
Ignition protection category	Basic principle	Schematic illustration	Principal application
Pressure-resistant capsule d	Ignition protection category in which the components which could ignite in a potentially explosive atmosphere are located in a housing which would withstand the pressure of an explosion of an explosive mixture inside and prevent the transmission of the explosion to the potentially explosive atmosphere surrounding the housing.		Command and display units, switching devices and switching systems, controls, motors
Increased safety e	Ignition protection category used for electrical resources, where additional measures are taken to achieve a higher level of safety to prevent the possibility of inadmissibly high temperatures and of sparks or light arcs forming in regular operation or under defined extraordinary conditions.		Terminal boxes, junction boxes
Intrinsically safe i	Electrical circuit in which neither a spark nor any thermal effects which occur under the conditions defined in this standard and which include certain fault conditions could cause the ignition of a given potentially explosive gaseous atmosphere.		Measuring and regulation technology, sensors, actuators

Fig. 5: Important ignition protection categories and principal field of application in overview

		T1	T2	T3
		450°C	300°C	200°C
Explosion group	IIB	City gas, Carbon monoxide	Ethylene R1150	Dimethyl ether
	IIA	Propane R290, Methane R50, Ethane R170	n-Butane R600 Ethanol	Petrol, Diesel, n-Pentane R601

Fig. 6: The additional identifier IIB T3 describes the possible gases in which the fan may be employed, and temperature class T defines the maximum permissible surface temperature.

Innovative gas heating for efficient heat


© fotolia

Economical use of heat energy, eco-friendly combustion technology and standards of comfort in operation are the principal requirements of heating sources in modern homes. Modern condensing boiler technology has been proven to be especially efficient for the environment and the purse. Compact dimensions, super-quiet operation and high efficiency are what characterise these units. A modular condensing boiler now goes one step further. The extremely compact heater comprises just four modules. That saves on installation costs, making an inexpensive end price possible.

“State of the art installations do not have to be complex and expensive”

“State of the art” installations do not have to be complex and expensive. That was the guiding principle upon which Remeha, a leading supplier of gas condensing boiler technology, together with the specialist for heating and ventilation technology, ebm-papst Landshut, developed a completely new concept for building gas condensing boilers. Instead of assembling many discrete individual components to form a single working entity, the engineers condensed the technology needed into functional modules. The new design permits an especially compact heating solution. The total weight of the modular Tzerra boiler is just 17 kg (see Fig. 1).

Safe, economical, quiet

Modern residential buildings and subsequently insulated old buildings need much lower heat output that they once did. The configuration of modern, universally employable gas boilers therefore has to cover in particular the lower heat output range. The space-saving boiler therefore delivers cosy warmth in a broad power range from 6 to 40 kW with dimensions of just 380 x 360 x 550 mm (W x D x H). To achieve this, the individual functions of the boiler were divided between the modules housing and frame, heat exchanger and burner, gas/air unit with burner control and hydraulics with recirculation pump (see Fig. 2). The engineers from ebm-papst Landshut developed the whole gas/air group, which was designed as a complete unit for the very first time. The module assumes the role of overall control of the boiler and delivers the homogeneous gas/air mixture that is needed for efficient combustion in the burner. Here, the standard individual components that were previously required such as blower, mixture adapter, the gas/air mixture controller, that is the so-called venturi jet, and the gas valve are combined to form a single function unit. For later operation, an intake noise damper, a non-return valve, the boiler control system, a


Fig. 1: The new compact boiler weighing just 17 kg has an output between 6 and 40 kW.


Fig. 2: The modular design comprises just 4 parts, making rational assembly possible.

safety assembly and the ignition transformer were added. The most significant new feature is the compact group of blower, gas valve, burner control and mixture adapter. An electronic circuit board houses the complete control of the burner control and the motor commutation of the blower in a compact module. The cooling of the electronic components which are subjected to higher loads is important for a long boiler service life. This is also integrated in the extremely flat module (see Fig. 3). The blower motor is designed as an especially flat internal rotor motor. That ensures high efficiency and fast readjustment. Moreover, the driver, which is inherently quiet, is also mounted in rubber buffers. That prevents structure-borne noise from being transmitted to the housing. On the air side, the aerodynamics have also been configured for maximum efficiency and minimum flow noise. Here, special consideration was given to the inlets and outlets of the blower, including inlet dampers and venturi jets, a development step that required not only experience and special computer programs, but also and in particular extensive practical testing.

"The goal of a boiler service life of at least 15 years could be achieved without problems"

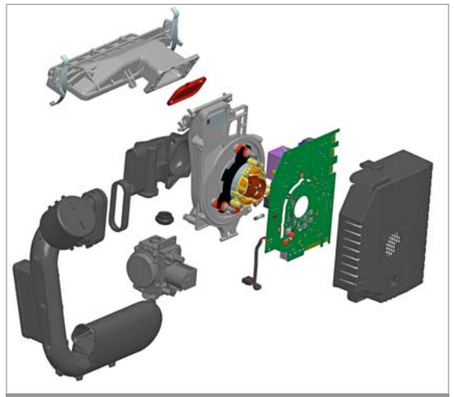


Fig. 3: All components accommodated in a very small space. The complex gas/air module with blower, motor, burner control, mixer and control board.

Long service life

The resulting compact module was then extensively tested by itself and in combination with the other components in the ebm-papst gas testing laboratory. Besides extensive (service life) endurance tests at maximum temperature loading in the climatic chamber, this also included shock and vibration testing. That was the only way to test the complete structure of all components in each module and the interaction between the modules realistically and practically. At the end of the day, the test demonstrated that the goal of a boiler service life of at least 15 years could be achieved without problems. Other test series examined the noise development of the motor and the inlet and outlet sides. New automatic testing with modified testing techniques were integrated into the newly installed series production facilities for the purpose of quality control (see Fig. 4). This makes it one hundred percent certain that all components satisfy the specifications and that the test values are comprehensively stored in a quality assurance database.

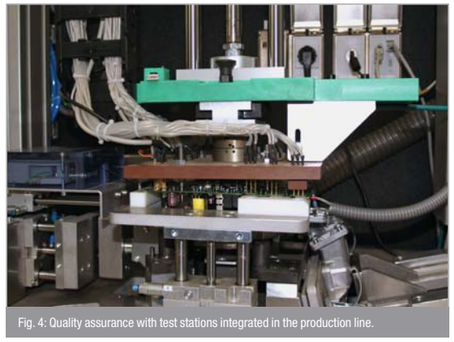


Fig. 4: Quality assurance with test stations integrated in the production line.

Substantial synergy effects can also be achieved in the field of gas condensing boilers by replacing discrete components with highly integrated technology. For example, the compact configuration of optimum gas/air combustion. The grouping together of all control components on a single circuit board saves space and increases reliability due to the reduced number of transition points. All in all, that means maximum convenience and reliability for the user and the end customer and at the same time much lower costs.

Gerhard Selmer
Key Account Manager
ebm-papst Landshut

Highly integrated gas/air module makes installation and maintenance easier for condensing boilers:
Innovative gas heating for efficient heat

"The grouping together of all control components on a single circuit board saves not only space"

What was that with current reverse transfer?

Fan efficiency has become a central issue in ventilation and air-conditioning technology. This is encouraged not only by the statutory basis created with the Energy Conservation Directive, but also by increased environmental and cost awareness on the part of users. Against this background, it comes as no surprise that energy-efficient EC technology is increasingly being employed in more and more areas, in large evaporators and heat exchangers and in control cabinet cooling.

Fig. 1: Fan efficiency has become a central issue in ventilation and air-conditioning technology. This is encouraged not only by the statutory basis created with the Energy Conservation Directive, but also by increased environmental and cost awareness on the part of users.

“On ebm-papst’s GreenTech EC motors, the complete control electronics are integrated into the drive”

In recent times, users of modern EC technology have been unsettled by reports of current reverse transfers caused by intermediate circuit capacitors. This is the case in particular for large systems which are equipped with a large number of EC fans and which are not switched off from the power supply when out of use (see Fig. 1). However, there is no cause for alarm. The switching technology employed in EC motors has been successfully established in a vast range of different applications for many years. The power electronics component needed for the variable-frequency output voltage adjustment is in principle identical in design in EC motors as it is in a frequency inverter for asynchronous motors. They only differ in their dimensions. On ebm-papst’s GreenTech EC motors, the complete control electronics are integrated into the drive to form a compact unit. Any problems that might occur with idle power or current reverse transfers are already known from speed-controlled asynchronous motors. It is easy to recognise that the intermediate circuit capacitor cannot cause any current reverse transfer when the drive is stationary, i.e. when the downstream frequency inverter draws no power. That quickly becomes clear when the way that EC motors work and their circuits are designed are scrutinised in more detail.

What happens at the capacitor in the intermediate circuit?

An EC motor is a permanently excited, brushless synchronous motor which is operated by a DC voltage via a control and power electronics unit (the so-called commutation electronics). With mains-powered commutation electronics, this DC voltage is generated by rectifying the AC mains voltage. The rectified voltage – the so-called intermediate circuit voltage – is smoothed by a capacitor – the intermediate circuit capacitor. Depending on the position and speed of the rotor, the commutation electronics use this DC voltage to generate a three-phase, speed-synchronous AC voltage of variable frequency and amplitude. The motor currents flowing through it generates the rotating field in the stator winding, causing the engine to turn.

EC motors under scrutiny:
What was that with current reverse transfer?

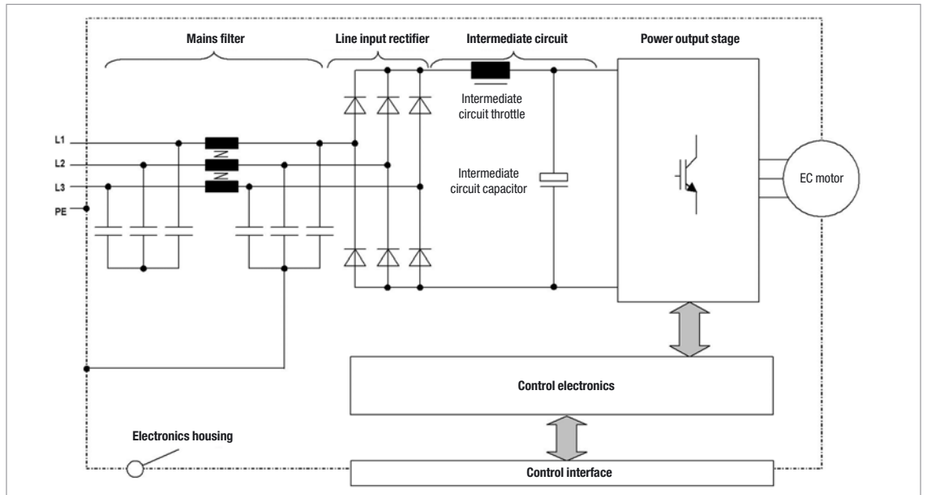


Fig. 2: Block diagram of the power electronics and of the integrated filter measures on an ebm-papst GreenTech EC motor for a 3~400 V three-phase current supply.

As a rule, the intermediate circuit capacitor is permanently connected to the 400 or 230 VAC power supply. A control input on the controller, e.g. 0 to 10 V is used to control the motor speed. Because the power electronics are not disconnected from the power supply when the motor is stationary, it could be concluded that the intermediate circuit capacitor remains active, causing an unwanted capacitive current reverse transfer. However, a look at the schematic (see Fig. 2) of an ebm-papst GreenTech EC motor will tell the specialist that this is not the case. If no current is drawn from the intermediate circuit, the capacitor will remain charged. No charging current flows through a charged capacitor. In this operating state there can therefore be no phase shift between voltage and current, no idle power, no harmonic waves and thus no current reverse transfer. It is therefore not necessary to disconnect the motor from the power supply when the speed is zero in order to avoid negative current reverse transfer in the intermediate circuit capacitor. Because air-conditioning equipment usually works continuously, this situation is in any case rather exceptional.

The capacitors in the power line filter

When the fan is running, the switching principle, which has been established for many years, is of course not free of reverse transfers from the power supply. When current is drawn for the motor, the (non-linear) charge current in the intermediate circuit capacitor loads the power line above all with higher-frequency impulses, so-called current harmonics. By contrast, the phase shift of the charge current is practically negligible (just a few degrees capacitive) (see Fig. 3). In order to reduce the current harmonics and the higher-frequency interference emissions (caused by the rapid switching in the power electronics) to a level compatible with standards, various measures have been integrated into ebm-papst GreenTech EC motors. Current harmonics are reduced by active or passive harmonics filters in the intermediate circuit, while higher frequency interference emissions at the power input of the commutation electronics are reduced by power line filters. There, anti-interference capacitors located between the live and the neutral wires or between the phases. The size of their capacitive values depends of the interference spectrum and the necessary degree of damping. The overall capacitance of the power line filter is usually in the range of a few 10 nF to a few µF. The capacitors, which are essential for interference suppression, cause a capacitive idle current. With a typically dimensioned power line filter, for example, for a three-phase-powered 3 kW GreenTech EC motor on a 400 V three-phase current supply (nominal power current 4.6 A) this is approximately 0.24 A, i.e. 5 % of the nominal current. So long as the power voltage is applied to the commutation electronics input, this idle current will flow, which in the above example causes a total idle power of approx. 160 VAr. The effective power draw in standby mode is approximately one per mil of the nominal output for a 3 kW GreenTech EC motor. This effective power draw is taken by the intermediate circuit capacitor, but the current for this is so small that it can be neglected compared to the idle current of the power line filter (see Fig. 4a and Fig. 4b, page 28). The idle current and idle power in standby therefore have nothing to do with the intermediate circuit capacitor, but rather are caused by the necessary use of power line filters.

“Additional control and switch-off mechanisms are thus unnecessary for GreenTech fans”

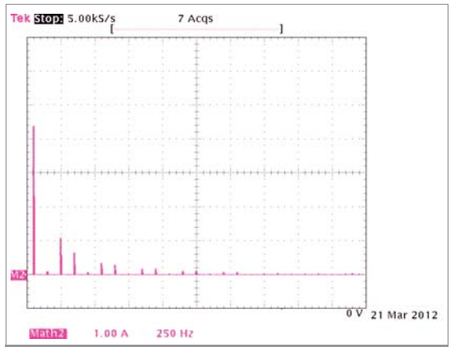


Fig. 3: Standard-compatible current harmonics spectrum of a phase current L1 on a 3 kW GreenTech EC motor at its nominal output; Vert.: 1A/Div; Horiz.: 250 Hz/Div. The distinct first harmonics and the orders 5, 7, 11, 13, 17, 19 can be recognised.

Better not too switch off

No problematic or inadmissible current reverse transfers are cause by the use of EC fans. Above all the ebm-papst GreenTech fans with their electronics satisfy the current, modern sate of the art for variable-speed drive technology with respect to current reverse transfers, and they are also compliant with relevant standards. Additional control and switch-off mechanisms are thus unnecessary. On the contrary, the capacitors in the power line filter can provide basic compensation for inductive idle power, which could mean savings in the dimensions of compensation systems. Moreover – if EC motors are switched off in standby mode – excessively

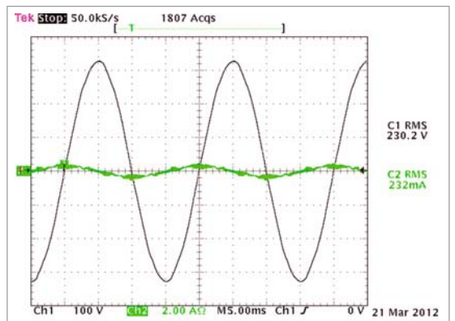


Fig. 4a: Phase voltage L1-N and phase current L1 on a 3 kW GreenTech EC motor at standstill; Vert.: 100V/Div; 2A/Div. The phase shift between current and voltage is close to 90°. This indicates a (practically) pure idle current draw of approx. 53 VAr per phase.

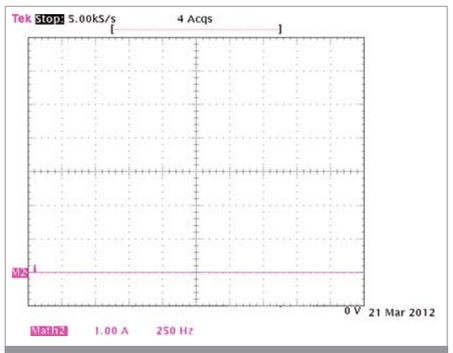
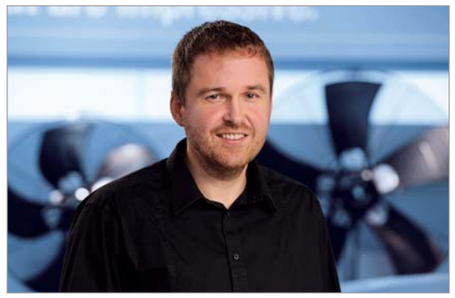


Fig. 4b: Related current harmonics spectrum of the phase current L1 on a 3 kW GreenTech EC motor at standstill; Vert.: 1A/Div; Horiz.:0 250 Hz/Div. Only the first harmonic with a value of 230 mA is visible.

frequent switching of the power voltage could reduce the service life of the equipment, just as it could with a frequency inverter. Switching off in standby mode is therefore only advisable in exceptional cases.



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