WHITE PAPER

Paths to a healthy indoor climate

Energy-efficient and quiet fans for residential ventilation

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Introduction

Today, important measures to save energy include building insulated low-energy houses and renovating existing buildings by using insulating windows and thermal insulation composite systems on the building envelope. Sealing it off in this way means that only a small amount of heat energy is lost. However, this often results in no guarantee of sufficient air circulation, as the manual ventilation is less than is required. This can result in mold formation, the reproduction of pathogens and too much CO_2 in the breathing air. Whether during hot periods or on cold days, modern centralized and decentralized ventilation systems are therefore the key technology for effective, health-promoting and climate-friendly ventilation management all year round. They ensure that air is exchanged based on demand and reduce heating energy demand through heat recovery. The fans used in them also contribute to this: Not only are they energy efficient, they are also extremely quiet and are suitable for almost any application thanks to a variety of different versions and properties.

1. Centralized or decentralized?

Depending on how the building is used, planners and operators can choose between centralized, decentralized or combined solutions (Fig. 1). In the past, centralized ventilation has shaped the market. In the meantime, decentralized solutions for individual rooms or smaller units of use are also widely used, as they offer options for adapting to the user's individual wishes, enable detailed individual billing and can usually be easily retrofitted. In addition, these devices are integrated directly into the building façade or windowsill and they do not require a duct system for supply and exhaust air. That is why they are ideal for renovating old buildings. In centralized systems, heat recovery and air filtration are easier and more effective to implement and performing maintenance work is easier to execute according to plan.

Both solutions therefore have advantages and can be combined if necessary. For example, fresh air can be provided centrally, while decentralized ventilation units in the individual rooms are responsible for the right temperature. The air is then heated or cooled where it is actually needed and the ducts for the (centralized) fresh air supply require significantly less space than for conventional central air conditioning.

Both solutions therefore have advantages and can be combined if necessary.

Fig. 1:
Depending on the use of the building, planners and operators have the choice between centralized, decentralized or combined solutions, e.g. with a heat pump.

2. Fans for centralized ventilation systems

Of course, the devices designed for the various ventilation concepts require different fans. Thanks to the large selection of EC fans available today, the advantages of energy-efficient technology can be used for all ventilation concepts. For example, motor and fan manufacturer ebm-papst has the right fan solution for all requirements in a broad product range. For the AHUs used in centralized ventilation concepts, the centrifugal fans in the RadiCal product range offer the ideal conditions.

The RadiCal 2 has an integrated air flow measurement using the integrated vane anemometer.

2.1. Centrifugal fans in scroll housing

With RadiCal centrifugal fans in scroll housings (Fig. 2), the round outlet is connected directly to the pipe socket at the air outlet of the ventilation unit. Users do not need their own air duct design, flow losses are reduced, air performance remains pressure-resistant and the efficiency increases by up to 34% compared to centrifugal blowers of the same design. At the same time, the noise emissions are reduced by around 3.5 dB(A).

A special feature of the series is the integrated air flow measurement using the integrated vane anemometer. It is positioned in the outlet nozzle of the scroll housing and continuously records the actual air flow without generating significant pressure losses or additional noise. The data is transferred to the fan's integrated central control electronics. This adjusts the speed of the EC motor to the desired setpoint and regulates the air volume of the blower to the specified setpoint regardless of air density influences. In many applications, this enables significant reductions in the energy consumption and noise emissions. The humidity and temperature sensors arranged in the air flow, the MODBUS RTU interface with its numerous communication options and connections for other sensors are also practical for central ventilation units. In addition, the centrifugal fans are designed as a plug & play system, enabling easy installation.

Fig. 2:
When it comes to RadiCal centrifugal fans in scroll housings, users do not need their own air duct design.

2.2. Compact centrifugal fans for high air flow rates

An ever lower energy consumption is required for devices in centralized residential ventilation. Manufacturers are responding to this by designing their devices for minimal pressure losses resulting from installation. At the same time, the devices need to be as compact as possible so as to minimize their footprint and have sufficient space inside for additional components. For this reason, there is a demand for compact fans that deliver large air flows with low back pressure while operating as energy-efficiently and quietly as possible. ebm-papst tuned the centrifugal fans in the RadiCal 2 series to meet precisely these requirements (Fig. 3a and b). Several design details contribute to this, making it possible to achieve a ‚wound' blade geometry that helps significantly increase efficiency and reduce noise. The blades are tilted both forwards and backwards and the profile of the inlet and outlet edges has been revised. This improves the flow behavior while at the same time increasing the strength of the fan impeller, which is made of resistant plastic. The wavy cover plate also improves the aerodynamic characteristics and hence the air performance. In the centrifugal module, a rea-

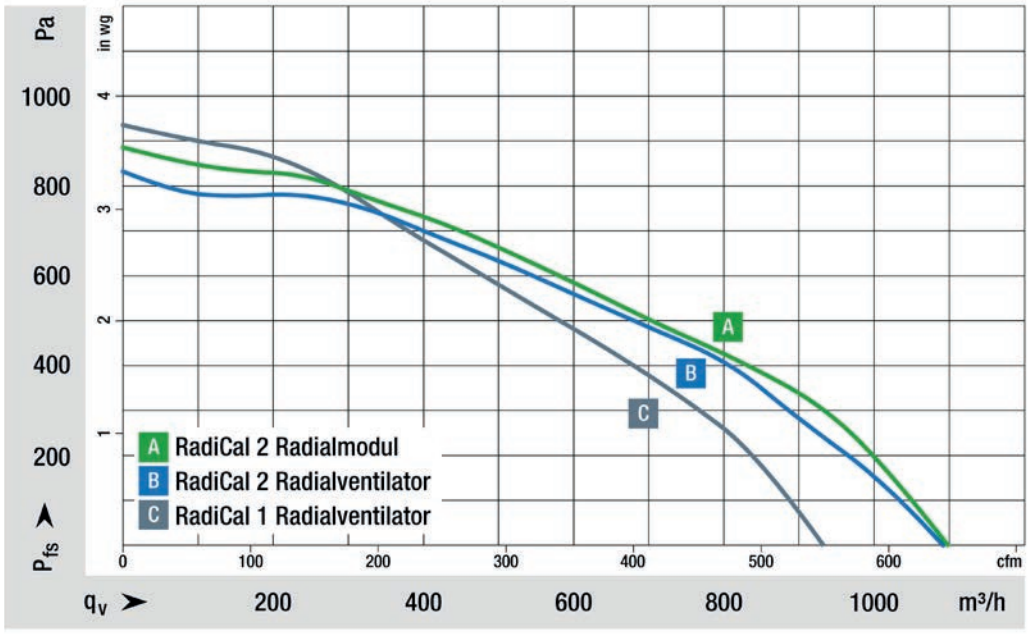

Fig. 3a

Fig. 3b

Fig. 3a and b:
The centrifugal fans in the RadiCal 2 series deliver high air flows at low back pressures.

dy-to-install support structure, the inclined struts further increase the air performance. The axial height of the struts is selected to fill the backflow areas in the best possible way. There is also an enlarged intake diameter, which ensures a greater air flow rate through the impeller.
The new air inlet grille also helps to prevent noise. Compared to the previous series version, both the intake side disturbance and the fan itself is quieter, between 1 and 3 dB(A). As the rotor area has a major influence on noise, the air inlet grille was also given a cap in the center. This enables the disruptive blade passing noise in the lower frequency range in particular to be significantly reduced. With regard to the environmental factor of „noise", the fans therefore meet the strictest requirements.

2.3. New generation of engines

The new EC motors also ensure quiet operation. Depending on the size of the fans, they cover a power range of up to 170 W for single-phase networks. There are no disruptive resonances when there is a change in speed. In addition to good noise characteristics, the new generation of motors also impresses with its EMC properties, good protection against environmental influences and durability. The commutation and control electronics are tuned to the motors and the air flow and operating point can be precisely adjusted. If there is imbalance, a warning message is issued. Control and monitoring are possible using 0 - 10 V/PWM or, as an option from the 170 W variant onwards, using MODBUS RTU. Networking via the communication bus then makes it possible to use the motor data for preventive maintenance measures, for example, or to quickly adapt the fans to changes in operating conditions.

The commutation and control electronics are tuned to the motors and the air flow and operating point can be precisely adjusted.

3. Fans for decentralized push-pull ventilation systems

The decentralized residential ventilation units installed in the façade are suitable for renovation work and are also gaining in importance as an alternative to centralized systems in new buildings. Push-pull ventilation units (Fig. 4) convey used air from the living space to the outside (push) for a defined period of time, usually around 60 seconds. The fan installed in the ventilation unit then changes its direction of rotation, i.e. it reverses (pull). During push operation, an integrated heat accumulator stores the heat energy from the exhaust air. In the pull phase, it is transferred to the fresh outside air so that it flows into the building preheated. A filter also clears dust and pollen from the air coming in from outside. Two units per room or zone are required to ensure balanced ventilation. In some cases, several rooms are ventilated using one

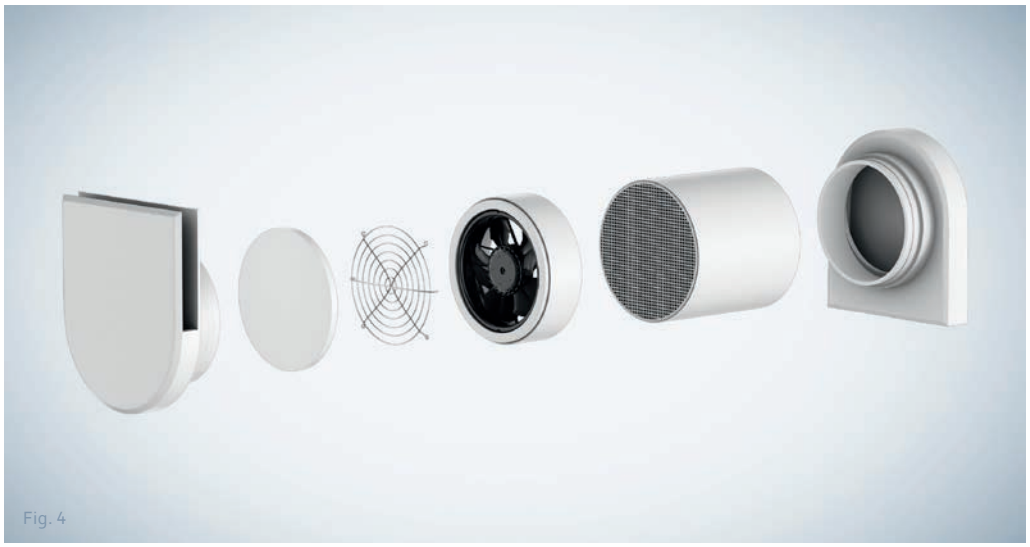

Fig. 4:
Push-pull system for decentralized residential ventilation with ceramic heat exchanger.

pair of units. Even with changing wind forces, the fans used in it have to deliver as constant an air flow as possible in both directions of rotation. However, this is not an issue for the new AxiRev reverse fan (Fig. 5).

The EC motor and fan geometry have been selected so that the fan is designed precisely for the operating points commonly used in push-pull systems. The characteristic curve for the pressure/air flow (Fig. 6) is very steep, which means that, even in stormy weather conditions, there are only slight fluctuations in the air flow. This means that wind and storms have little influence on the efficiency and function of the decentralized residential ventilation unit. The blade design is almost symmetrical and ensures that the characteristic curve and so too the volume of air conveyed are identical in both directions of rotation. In a push-pull application, the

Even with changing wind forces, the fans used in it have to deliver as con-stant an air flow as possible in both directions of rotation. However, this is not an issue for the new AxiRev reverse fan.

Fig. 5

Fig. 5:
With the AxiRev reverse fan, the EC motor and fan geometry have been selected so that the fan is designed precisely for the operating points commonly used in push-pull systems.

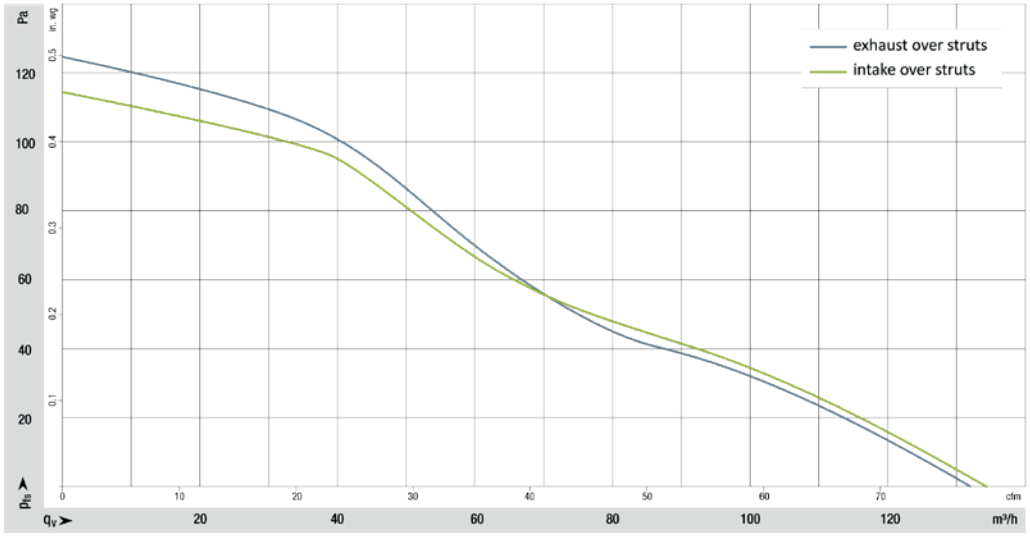

Fig. 6

Fig. 6:
The pressure/air flow curve of the AxiRev is very steep.

fan then typically changes the direction every 60 to 70 seconds, meaning that residential ventilation can work effectively in a paired operation (Fig. 7).
This is based on a wide range of design and aerodynamic details. These include, for example, the „flat fitted" blades that enable higher pressures. The patented blade design with striking blade tips and the openings at the blade ends minimize the noises induced by tip gap vortices, which reduces the noise emissions. The adjustment of the number of blades and the number of struts for the motor mounting also plays a role here. The thirteen struts with an aerodynamic profile also reduce turbulent trails, which ensures a very good psychoacoustic noise quality. This means that the fan is not only quiet but its operating noise is also perceived as pleasant. What's more, the three-strand EC motor, designed specifically for this application, works without disruptive commutation noise, and switching between the directions of rotation is not noticeable.

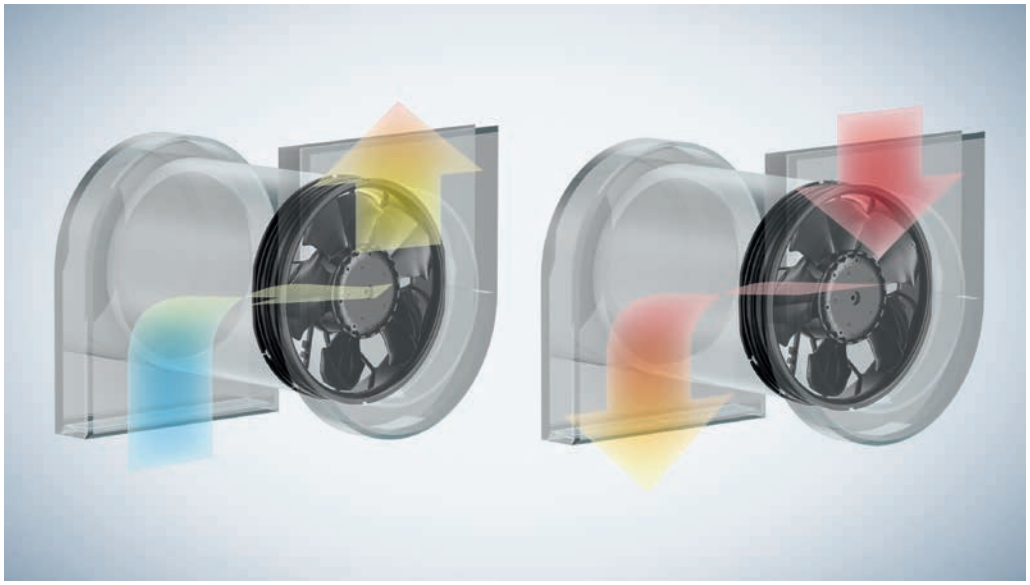

Fig. 7

Fig. 7:
No matter which direction: the air volume is the same. The AxiRev 126 is striking due to its characteristic appearance: The symmetrical blade design enables identical characteristic curves in both directions of rotation.

4. Quiet running for smaller decentralized ventilation units and wet room ventilation

Even small systems for decentralized residential ventilation, which are usually designed with heat exchangers and move around 60 to 70 m³ of air per hour, need energy-efficient and quiet fans. One option is the RET centrifugal fan series with forward-curved blades available in sizes 85 to 108 (Fig. 8). The blade design, combined with three-phase silent motor technology with its low-noise commutation electronics, ensures little operating noise. The same EC motors are also found in the flatter centrifugal fans in the RER series (Fig. 9). They are also available in a scroll housing (RG). You can use it directly as a plug & play solution. On the unit side, no additional installations are necessary for conducting air.

Small decentralized ventilation systems also include sanitary and wet room ventilation. An exhaust air system is absolutely essential for wet rooms with no windows, such as bathrooms and toilets. The fans used have to deliver high air performance in the smallest of spaces and operate as quietly as possible. Moisture protection measures are also required at the motor. (Fig. 10). Small axial compact fans with PWM control input and an optional analog input, for example for humidity detection sensors, are well suited for this area of application. These are very robust with protection against moisture in class IP68, have few vibrations and operate extremely quietly. The compact duct fans with boost function and centrifugal blowers, which deliver a very constant air flow (Fig. 11), are also designed for use in wet room ventilation. This means that a suitable solution can be found for almost every residential ventilation task that ensures a pleasant indoor climate in an energy-efficient and quiet manner.


Fig. 8

Fig. 8:
In the RET centrifugal fan series, the three-phase silent motor technology with its low-noise commutation electronics ensures low operating noise levels.


Fig. 9

Fig. 9:
Flat centrifugal fan from the RER series.

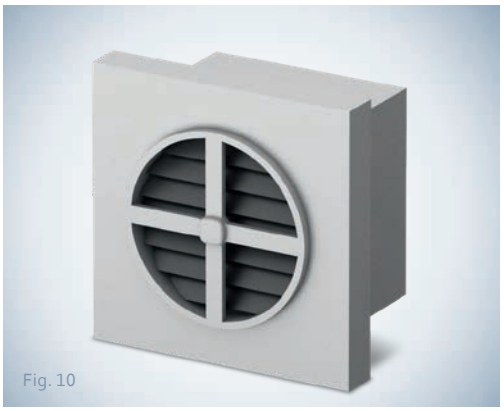
Fig. 10

Fig. 10:
Small decentralized ventilation systems also include sanitary and wet room ventilation. An exhaust air system is absolutely essential for wet rooms with no windows, such as bathrooms and toilets. The fans used have to deliver high performance levels in the smallest of spaces, while being as quiet as possible and with moisture protection.


Fig. 11

Fig. 11:
Centrifugal blowers are also designed for use in wet room ventilation, delivering a very constant air flow.

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5. Quiet running for smaller decentralized ventilation units and wet room ventilation

Indoor air quality (IAQ) is an increasingly important issue today in both commercial and private residential buildings. Digitalization and cloud applications help visualize IAQ. The data collected in the process forms the basis for automated control of all components. The aim is to ensure good air quality in a way that is both needs-based and energy efficient. Together with its subsidiary ebm-papst neo and partner RESET, ebm-papst supplies all the components required for this, from smart sensors and soft sensors to a cloud-based Building Connect platform and an intelligent fan (Fig. 12).

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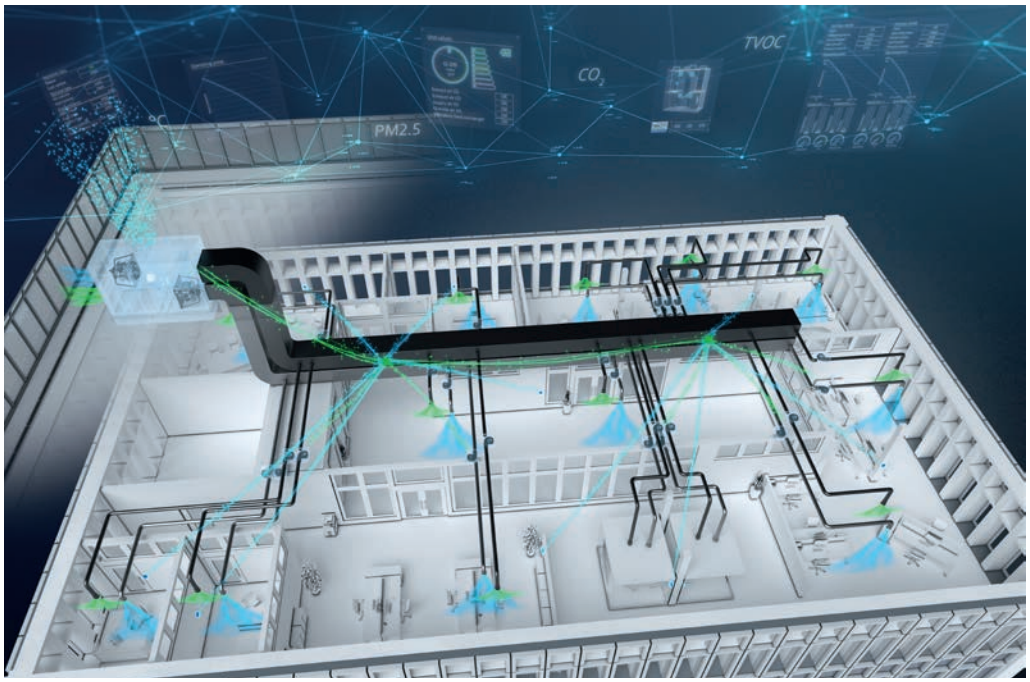

Fig. 12

Fig. 12:
Together with ebm-papst neo and partner RESET, ebm-papst supplies all the components required for this, from smart sensors and soft sensors to a cloud-based Building Connect platform and an intelligent fan.

Fig. 13

Using this as a basis, the experts are happy to develop use-based, individual solutions suitable for use in various applications. One example of this is the Urbanharbor in Ludwigsburg, one of Europe's first climate-neutral urban districts. Fresh air is efficiently supplied by an innovative semi-centralized ventilation system – with fans from ebm-papst and a digital cloud solution from ebm-papst neo (Fig. 13).

Fig. 13:
Urbanharbor in Ludwigsburg is one of Europe's first climate-neutral urban districts. An innovative semi-centralized ventilation system provides an efficient supply of fresh air.

About ebm-papst

The ebm-papst Group, a family-run company headquartered in Mulfingen, Germany, is the world's leading manufacturer of fans and motors. Since it was founded in 1963, the technological leader has set international industry standards with its core competencies in motor technology, electronics, digitalization, and aerodynamics. ebm-papst offers sustainable, intelligent, and tailor-made solutions for virtually every requirement in ventilation and heating technology.

In the 2022/23 financial year, the Group generated turnover of EUR 2.540 billion. It employs just under 15,000 people at 30 production sites (including in Germany, China, and the U.S.) and in 50 sales offices worldwide. ebm-papst sets the benchmark in almost all sectors, such as ventilation, air conditioning and refrigeration technology, heating technology, information technology, mechanical engineering, intralogistics, and medical technology.

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