

## FANS & BLOWERS

Mechanical compatibility: The new EC motor (on the left) can be attached in exactly the same way as standard AC motors (on the right). Source: ebm-papst



# Efficient, Compact EC Motors for High Performance Fans and Blowers: The Future of Refrigeration, Air Conditioning and Building Systems

*Conventional AC motors can be replaced with highly efficient EC versions with the same mechanical design.*

by gunter streng

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Society is facing considerable challenges in light of global warming and rapid world population growth. One is partly the result of burning fossil fuels while the other places a greater burden on the energy delivery infrastructure in general. This makes reducing energy consumption a top priority in mitigating both of these issues. According to the World Health Organization, there is a direct correlation between world population growth, increasing CO<sub>2</sub> emissions and the demand for electricity. In this context the concept of "energy efficiency" takes on major significance with a view to meeting the extra energy demands of the future. In the field of refrigeration, air conditioning and building systems, the use of energy-saving drive units for fans and blowers can make a great contribution to such efforts.

The influence of energy-saving fans on energy consumption and CO<sub>2</sub> emissions can

best be illustrated by a concrete example. AC line powered asynchronous motors are frequently selected as drive units in refrigeration, air conditioning and building systems. These motors are of simple, compact design as they take their supply directly from the power grid without the need for any mechanical commutators or electronic components for the motor to operate. They are generally robust and reliable. Their major drawback is comparatively poor efficiency, particularly in the part-load range where they are clearly inferior to that of electronically commutated (EC) motors. This has an influence on power consumption in virtually all applications.

### An impressive set of figures

A typical smaller frame AC motor, widely used in all manner of applications, provides a very clear example to illustrate the point. Looked at over the past five years and assuming an average power consumption of



Compact electronics, encapsulated stator and rotor. Source: ebm-papst

150 W and a duty cycle of 75%, the annual energy consumption of the approximately 25 million motors of this type employed as fan drive units in various applications was close to 25 billion kWh. For reference, the 99 nuclear reactors in the USA produced a total

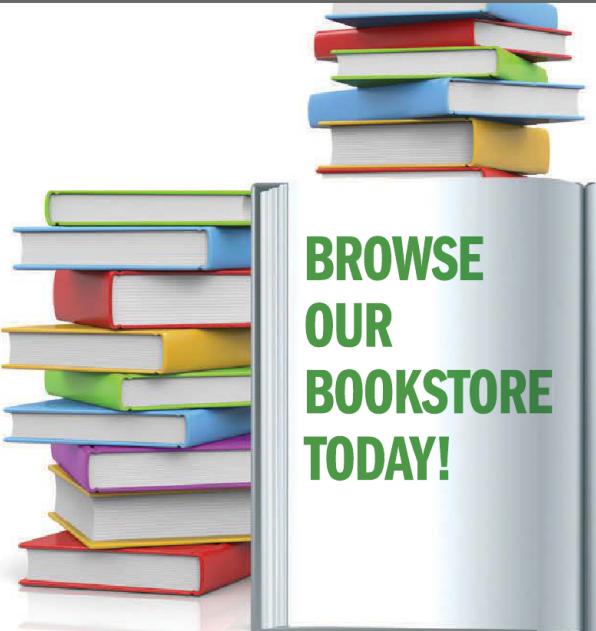
of 798 billion kWh in 2014, for an average of 8.1 billion kWh per reactor. That means the average annual output from three nuclear reactors is needed to supply the power for just these small frame AC motors used in various fan applications in refrigeration, air

conditioning and building systems.

## "AC to EC" - exchange made easy

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# FANS & BLOWERS



Ventilated facade systems with EC centrifugal or tangential blowers. *Source: ebm-papst*



Air curtain: The blowers are constantly in operation; a considerable amount of energy can therefore be saved by switching to EC motors. *Source: ebm-papst*

to the development of a new series of EC motors, conventional AC motors can be replaced with highly efficient EC versions with the same mechanical design. It is basically the same process as for old 100 W bulbs. These can be replaced by energy-saving bulbs which fit in the same socket. The development of EC motors that are mechanically compatible with AC motors and their extremely compact design did however represent something of a technical challenge.

The EC motor concept is based on synchronous motors with permanent magnet excitation. The magnetic rotor operates in sync with an electronically generated rotating field. This makes it possible to achieve any required operating speed irrespective of the AC line frequency. Accommodation of the electronics required for EC motors in a confined space demanded a lot of experience and expertise. Mechanical compatibility was also necessary in addition to the miniaturization and optimization of the electronics. This included employing the same type of

mounting flange as for AC motors as well as modification of the motor design as a whole.

## Good heat dissipation, high degree of protection and sustainable design

The results are impressive. The new compact EC motors are based on the successful external rotor principle in which the rotor rotates about the internal stator. A number of practical advantages are gained from the thermoplastic encapsulation of the laminated core of the stator. The high-grade plastic material provides excellent electrical insulation and it is possible to integrate the ball bearing mount. This permits variation of the wall thickness and spacing, making it easy to compensate

for laminated core tolerances. Finally, the entire wound stator assembly is encapsulated in thermosetting plastic. The one-piece rotor moving around the stator is of optimum aerodynamic design. Air inlets in the rotor ensure ideal dissipation of the stator heat. In combination with the encapsulated stator the motors have a guaranteed high level of IP protection (IP54). Sealing of the electronics also plays an important role. In contrast to previously used concepts involving a flange and various O-rings, the electronics housing was provided with an elastomeric sealing component to ensure long-lasting protection of the electronics. The entire motor is robust and shock-proof while offering outstanding reliability and a long service life.



In spite of the integrated commutation and actuation electronics, the new EC motors (on the right) are just as compact as conventional AC motors (on the left), thus permitting simple mechanical exchange. *Source: ebm-papst*



EC fans, optimized for use with evaporators in cold storage areas. *Source: ebm-papst*

When designing and manufacturing the new EC motors, great emphasis was also placed on sustainability and the preservation of resources. This is demonstrated by a variety of details. For instance, the one-piece rotor with press-fit shaft reduces the number of manufacturing steps and fewer parts are required thanks to the use of multi-function components. The heat dissipation concept and a relatively short core also help to reduce the amount of material, which adds up to less energy used in manufacturing.

## Convincing practical examples

The energy efficiency of EC motors is also associated with other properties which have a positive influence in everyday operation. These include speed control by way of the integrated electronics. The speed can thus always be matched to the given system requirements. What's more, EC motors are much quieter running than speed-controlled asynchronous motors on account of the noise inevitably generated by the triac or frequency converter control employed by the latter. Other advantages are the high power density, the compact size and the monitoring

function which permits querying of operating data and statuses at all times.

A variety of applications already implemented provide ample evidence of the environmental, financial and practical benefits to be gained by swapping from AC to EC motors in refrigeration, air conditioning and building systems. One such application is the so-called air curtain. This involves blowers creating an air flow barrier, usually employed to separate warm indoor air from cold outdoor air. EC blowers operate with outstanding efficiency and allow adaptation of the air flow velocity to suit requirements, e.g. air flow reduction when the door is closed, switching between winter and summer mode and day/night-time settings. Matching the blower performance to these part-load requirements can result in significant power savings and lower acoustic noise levels.

This applies similarly to the evaporator fans used around the world in refrigeration systems, where these systems operate continuously. EC fans designed especially for this sort of application are able to withstand the cold and moist operating environment, adding little heat to the refrigeration system thanks to the high level of motor efficiency at

full or part-loads.

Ventilated building facade systems are yet another example of successful conversion to EC motors. These systems provide a ventilated air gap combined with an insulating layer applied on a building's exterior walls to improve the building's thermal efficiency. Here, the compact design and demand-based regulation of EC centrifugal or tangential blowers offer key benefits.

## One nuclear power station less

There is no end to the list of possible examples, encompassing EC blowers in range hoods or clothes dryers, duct fans, fans in refrigerated display cases and a whole host of other applications. Common to all is a roughly 40% average reduction in power consumption upon switching from AC to EC motors. If all 25 million AC motors in our earlier example were replaced by EC versions, this would amount to a potential average energy savings of nearly 10 billion kWh, permitting an entire nuclear power station to be shut down. That would be an indisputable contribution to reducing future energy consumption. ■

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