Improve fan efficiency: save £18bn a year

According to the *2002 Market Study for Improving Energy Efficiency for Fans* (published by Fraunhofer IRB Verlag), it is estimated that the total energy consumption of fans installed in the UK is 2.85 x 10^{10} kWh per annum and that they cost £72 billion to operate. The application of energy-efficient fan technologies, and improvements to the systems in which they operate, provides scope to reduce this energy consumption by 20-25% - a potential saving of £18 billion and 3.2 million tonnes of carbon dioxide per year.

For those attempting to characterise the market for air-movement systems, and thus make strategic decisions on which energy-efficient products to develop, the diversity of applications is bewildering. In the commercial and industrial arena, there are air handling units, a portmanteau term for a range of air movement, heating and conditioning devices; in-line fans; twin fans, that peculiarly British invention; heat recovery units; fan coils and roof fans to name but a few. But, although it might at first seem counterintuitive, it is systems designed for small to medium duties that provide the greatest potential for energy reduction and that are worthy of closer consideration. For example, 80% of AHUs have capacities of 3.0m^3/s or less.

Traditionally, AHUs have been fitted with belt-driven centrifugal blowers: simple, cheap and readily available. However, it is widely accepted that direct-drive fans offer a more efficient air movement solution. Moreover, with the development of new, energy-efficient motor technologies, it is direct-driven fans that are set to dominate this sector in the future.

ebm-papst has manufactured direct-driven fans with high-efficiency DC motors for over twenty years. These have been used extensively in high-technology sectors, such as IT, where DC power supplies are ubiquitous. However, for HVAC applications, where DC supplies are rarely found, and where typical duty requirements are higher, adoption of this technology has been low. Then approximately six years ago, ebm-papst introduced a range of electronically-commutated (EC) fans specifically targeted at HVAC manufacturers. EC fans combine the benefits of DC motor technology – high electrical efficiency and silent, infinitely-variable speed control – with the familiarity of AC motor installation. The EC motor can be connected directly to mains electricity, with no requirement for a separate DC power supply.

To illustrate the extent to which EC motor technology can improve the efficiency of air movement products, the table below compares measurements taken from a supermarket air handling unit with a design duty of 3 m^3/s at 650 Pa. Calculations are based on 24-hour operation, an electricity tariff of £0.07/kWhr and 1 kWhr = 0.43 kg CO_2

Fan Technology	Power Consumption	kWhr/Year	Energy Cost/Year	Specific Fan Power (SFP)	CO_2/year
15/15 Belt-Drive Blower	6.30 kW	55,188	£3,863.16	2.10 W/l/s	23,731 kg
630mm EC Fan	3.45 kW	30,222	£2,115.54	1.15 W/l/s	12,995 kg

Until recently, the EC product range consisted largely of backward-curved centrifugal fans, presented either as motorised impellers or as frame-mounted “plug fans”. These single-inlet fans, with impeller diameters ranging from 133mm to 630mm, and power consumptions from 30W to 3kW, are capable of air volumes up to 16,000 m^3/h (4.4m^3/s), at typical operating pressures of 500-800 Pa. While backward-curved impellers, particularly those with 3-D aerofoil blades, provide the most energy-efficient solution for air movement devices, some manufacturers have been reluctant to redesign their equipment to incorporate this technology. Backward-curved fans are typically used without a scroll housing to direct the air flow: the air is discharged radially and is used to pressurise a plenum that has one or more outlets depending on the application.

Now, ebm-papst has developed a complimentary range of EC fans with forward-curved centrifugal impellers. These are offered as double-inlet blowers, with impeller diameters from 133mm up to 454mm (18/18 Imperial dimension), capable of producing air volumes of up to 20,000 m^3/h (5.5 m^3/s). The traditional blower configuration enables manufacturers to use EC technology in existing unit designs, and to offer the end-user a choice of fan and motor control options. And, in fact, it is the integrated speed-control functionality of EC motors that can provide the greatest value to the OEM and end-user.

The power required to rotate an impeller varies in proportion to the cube of the impeller speed. In other words, halving the speed of a fan can reduce power consumption by as much as factor of eight. So, it clearly makes sense to match fan speed to variations in demand. Traditional methods of speed-controlling AC motors, such as tapped transformers and phase-chopping devices, do reduce energy consumption, but also increase motor slip and waste some of the energy dividend through the generation of excess heat. EC motors, on the other hand, are controlled electronically and waste little or no heat. Furthermore, infinitely-variable speed control is achieved by the application of a simple 0-10V or PWM control signal directly to the motor: there is no need for separate control gear.

Forward-curved centrifugal fans with EC motors can also provide “sensorless” constant volume or pressure functionality. The integrated control electronics compares motor speed and current draw with data held on an internal look-up table. The motor automatically modulates speed to maintain the required duty point to within ±5% of the required value.

So, to summarise, the new range of ebm-papst EC blowers offers the OEM a simple and cost-effective way of introducing energy-efficient technology into their products, and of adding value to their products through additional functionality.