Energy saving through EC Fan Technology

Geoff Lockwood, Technical Director ebm-papst UK





ebmpapst

Learning Aims and Objectives

- Understanding of AC and DC fan technology
- Understanding of EC technology
- How the technologies compare
- How this impacts upon energy efficiencies
- How this can impact upon the Built Environment
- Relevance of current and future regulations
- Opportunities presented by EC technology

ebm-papst

- Europe's largest motor and fan manufacturer
- Wide range of products
- Market leader
- Exclusively OEM market
- Product range includes 14,500 variants

ebm-papst Green Tech

- Green Tech commitment
- Includes materials, processes, flow behaviour and power requirement
- Products that;
  - > Use recycled materials
  - > Conform to relevant standards
  - > Energy efficient
  - > Reliable
  - > Fully recyclable

ebm-papst Green Tech

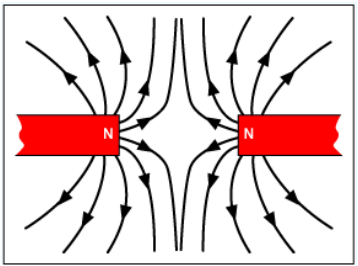
- Reduced use of aluminium replaced with light, aerodynamically formed plastics
- Intelligent solutions employed within the production process
  - > Use of PV for power generation
  - > Ventilation and cooling system that exploits residual heat
- Products meet and surpass future energy usage limits planned by the EU
- All manufacturing is carried out in accordance with ISO 14001

Energy saving through EC Fan Technology

AC, DC AND EC MOTORS

Electric Motor Principles

- Electric motors operate on the principle that like magnetic poles repel each other
- Rotating a magnetic field in the motor stator causes the magnetic field in the rotor to move away from it
- Repelling the rotor magnetic field causes rotation of the rotor
- The main difference in motor types is how the rotor magnetic field is created

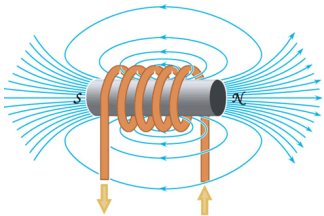


Electric Motor Principles

Magnetic fields can be created in two ways;

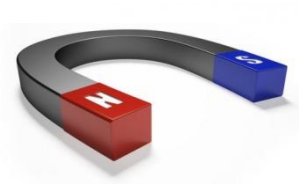
1. Passing a current through an electrical conductor to produce an electro-magnetic field.

   This is the method used in AC motors.



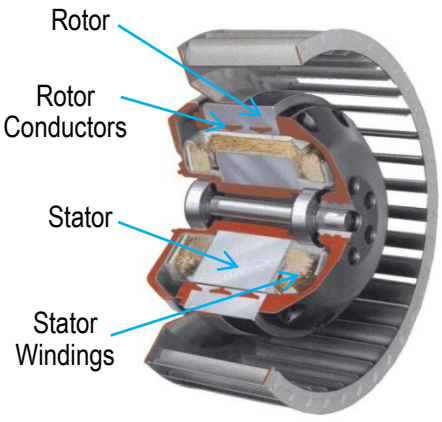
2. Using a permanent magnet.

   This is the method used in DC and EC motors.



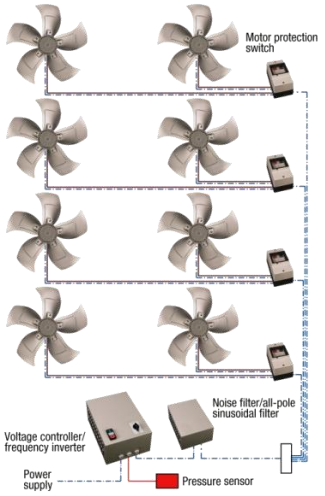
AC fan technology

- Traditional fan technology uses an AC motor
  - > Stator windings are supplied with AC current to produce the stator magnetic field
  - > Secondary magnetic field induced in rotor
  - > Opposing magnetic fields cause rotation of rotor
- Additional energy is consumed in inducing a secondary magnetic field



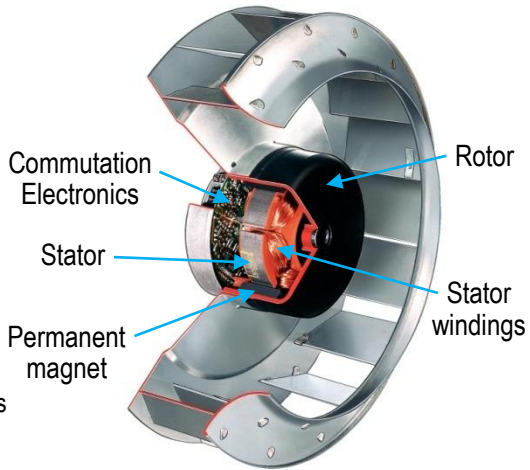
AC fan technology

- Not all AC motors are suitable for speed control
- Speed control requires additional voltage controllers or variable speed drives (VSD)
- VSD use requires filters to protect motor and may induce motor noise
- VSD consumes additional energy and reduces overall efficiency of system



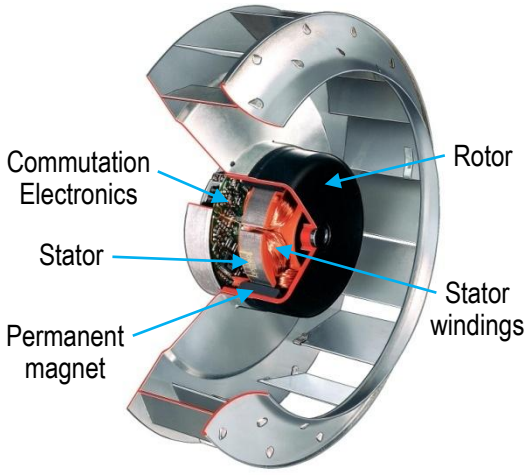
DC fan technology

- DC fans use a brushless DC motor
  - > Stator windings are supplied with DC current to produce the stator magnetic field
  - > Motor electronics control the current through the windings to offset the stator magnetic field
  - > Rotor magnetic field created by permanent magnets
  - > Opposing magnetic fields cause rotation of rotor
- Motor speed controlled by
  - > Changing the supply voltage
  - > Giving a reference signal to the internal electronics



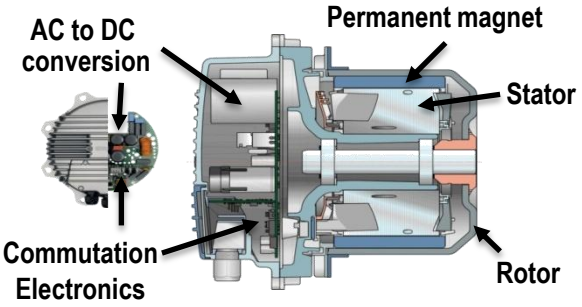
DC fan technology – Brushless DC motor

- More efficient than an AC induction motor
  - > Permanent magnets provide secondary magnetic field
  - > The induction process is no longer required
  - > Fewer conductors = reduced copper losses
  - > Accurate micro-processor control of primary magnetic field
- Higher efficiency = lower running temperature = increased life expectancy
- Reduced starting current with soft start



EC fan technology with Permanent Magnet Motor (PMM)

- EC stands for ‘electronically commutated’
- Same principle as DC motor but with onboard conversion of the AC supply voltage to DC
- Integrated electronics provide an intelligent motor
- Infinitely variable speed closed loop speed control possible through low voltage (0-10V) DC input

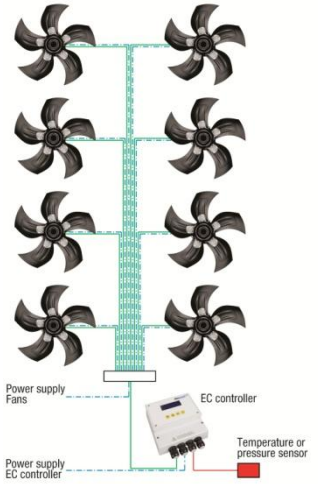


EC fan technology with Permanent Magnet Motor (PMM)

- EC motors are up to 30% more efficient than AC motors
- This is because:
  - > Secondary magnetic field comes from permanent magnets rather than copper windings
  - > AC motors consume additional energy solely to create a secondary magnetic field
  - > Electronics continuously monitor motor speed and adjust power input to optimise energy usage
  - > Motor efficiency is maintained across the speed range rather than at a specific design speed

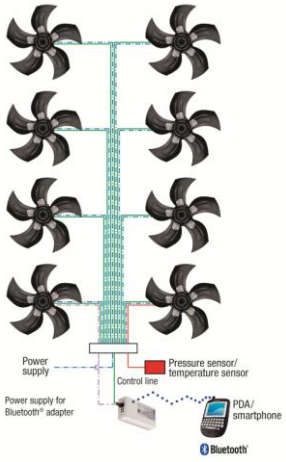
EC fan technology with Permanent Magnet Motor (PMM)

- No need for additional motor protection, voltage controls, noise filters or frequency inverters
- Integrated electronics allow a network system of many fans
- Greatly simplified wiring and uncomplicated connections
- Fan automatically regulates its own energy consumption
- Monitored remotely using a computer or other remote device

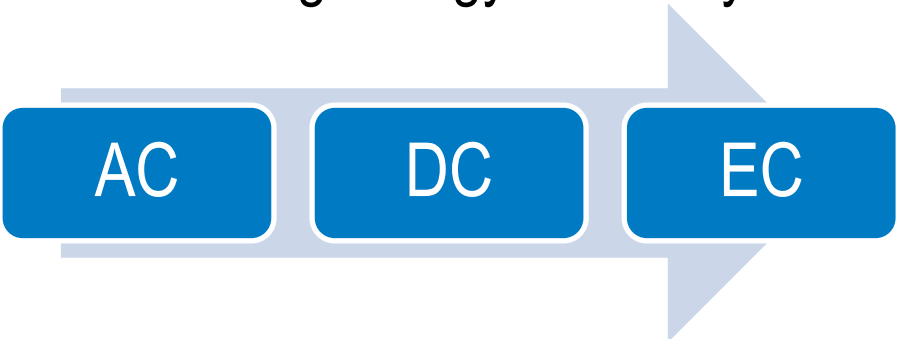


EC fan technology – alternative control

- Difficult to access applications
- Simplified Control



Increasing Energy Efficiency



Energy saving through EC Fan Technology

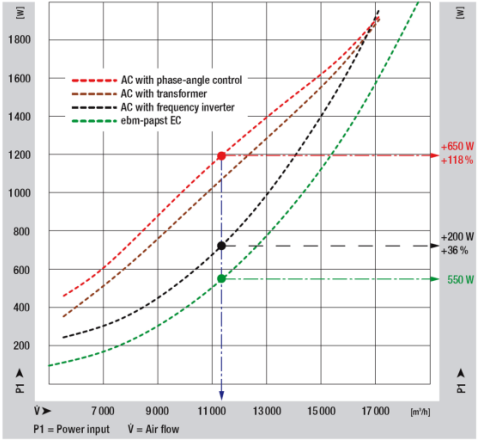
COMPARISON

AC v's EC – how the technologies compare

- Energy efficiency
  - > EC technology offers energy savings of up to 70% through;
    - > Elimination of secondary windings and resultant losses
    - > Cool running motors reducing the overall demand on refrigeration and cooling systems
    - > Halving the speed of a motor reduces its power input by a factor of eight
    - > Integrated electronics of EC technology optimise the benefits of this by;
      - > Ensuring motor efficiency is virtually constant at any speed
      - > Providing simple open or closed loop speed control by simply connecting a sensor
      - > Precise control of fan speed against system demand
      - > Master/Slave operation of multiple fans against programmable parameters
      - > Direct connection to bus networks and BMS systems

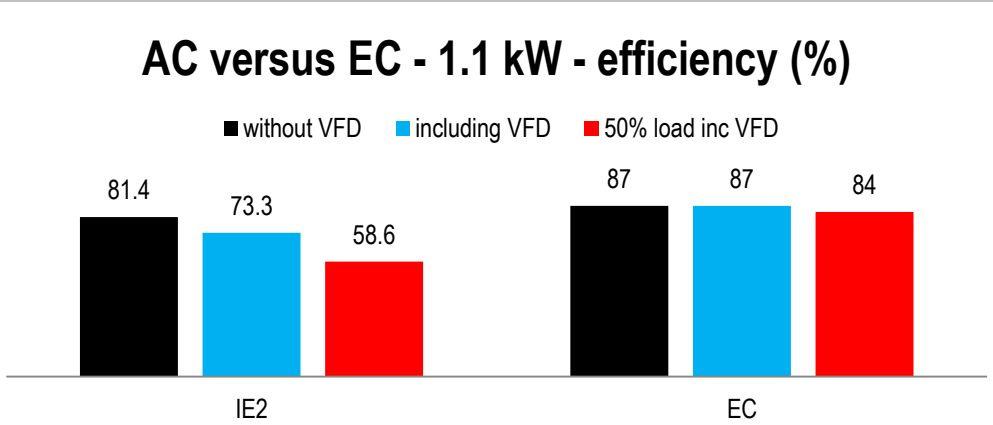
AC v EC – how the technologies compare

- Energy efficiency
  - > HVAC Example



Power input for various control methods

AC v EC – how the technologies compare



Overall efficiency of the AC motor is affected by the efficiency of the VFD and slip in the motor under speed control. The effect of speed control on EC motor efficiency is minimal.

AC v EC – how the technologies compare

- Control and Monitoring
  - > Integrated demand based control of fan speed means that the fan is only used when needed
  - > Continuous speed adjustment reduces noise, provides a more even flow of air and reduces energy consumption
  - > Simply connect a sensor to the motor for demand control against any parameter

- Refrigerant pressure

- Temperature

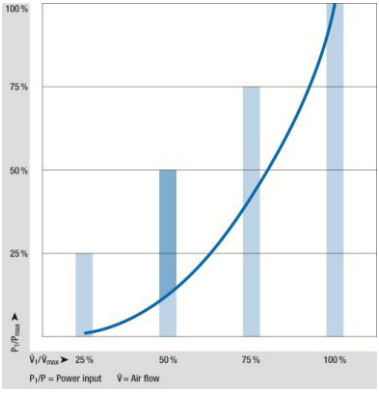
- Air pressure

- Air volume

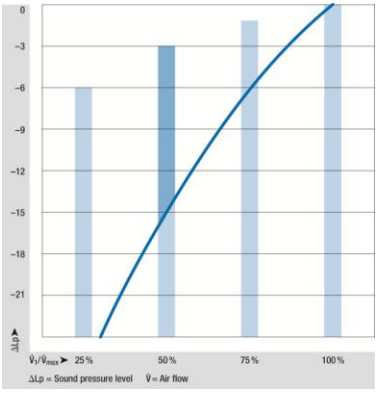
- Manual setting

- Any sensor

AC v EC – how the technologies compare
Continuous speed adjustment



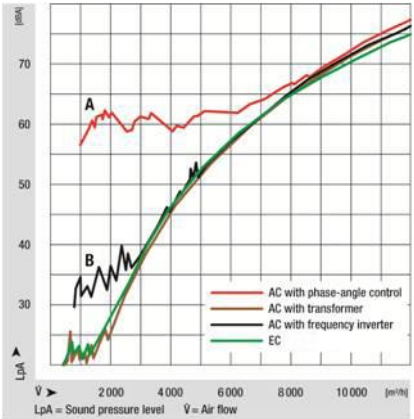
Lower energy consumption: The bars show the power input of fans that are switched on or off. The blue line shows the power input with continuous speed adjustment.



Lower noise: While shutting off half of the fans (one-half of the air flow) decreases the noise level by only about 3 dB, speed reduction to one-half the air flow attains an improvement of 15 dB.

AC v EC – how the technologies compare
Acoustics

- Acoustics
  - > EC fan technology is quieter than other technologies
    - > No motor noise due to voltage chopping in electronic speed controllers
    - > No motor noise due to switching frequencies of inverter drive control
  - > Simple, infinitely variable speed modulation eliminates the nuisance noise associated with on/off cycling

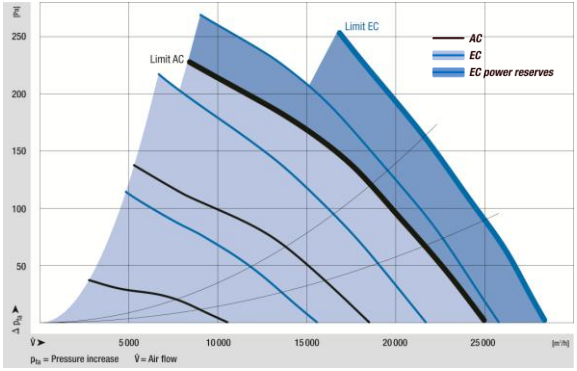


A: Phase-angle control, hum noise (300 Hz)

B: Frequency inverter whistle – motor and device resonance caused by frequency inverter-controlled motor

AC v EC – how the technologies compare

- Increased duty
  - > AC motor speed is limited by motor electrical design (no. of poles) and supply frequency unless used with additional frequency drives
  - > EC motor speed is regulated by the motor electronics and limited only by the structural design limits of the impeller



Energy saving through EC Fan Technology

THE BUILT ENVIRONMENT

Energy Savings in the Built Environment

- EC technology can provide significant energy savings within the built environment
- Fans will be found in a range of services including:
  - > Air Conditioning
  - > Ventilation and Heat Recovery
  - > Heating
  - > Refrigeration
  - > Humidification
  - > Condensers
  - > Evaporators
  - > Laminar flow units
  - > Fume and dust control

Energy Savings in the Built Environment

- Potential energy savings:

  > **Axial Fan** **Up to 29.1%**

  > Used in heat exchangers, ventilation, air-conditioning, cold storage and refrigeration

  > **Radial Fan** **Up to 21.5%**

  > Used in roof fans, air handling units and clean rooms

Energy Savings in the Built Environment

- Air-conditioning, heating, ventilation and refrigeration are high users of energy
- Specification of equipment using EC technology can make considerable energy savings and improve Energy Performance Certification
- EC technology fans have been designed to easily replace AC fans
- EC fans bring additional benefits of reduced noise, constant monitoring and simple control
- EC controllability can result in additional system energy savings

Energy saving through EC Fan Technology

REGULATIONS AND INCENTIVES

Regulations and Incentives

- 2010 Building Regulations Part L
  - > Part L sets standards for specific fan power in watts/litre/second (w/l/s)
  - > Part F sets minimum ventilation rates due to increased air tightness of buildings
- Energy related Products directive (ErP – formerly known as EuP)
  - > Only IE2 (EFF1) motors allowed from June 2011
  - > Only IE3 motors (or IE2 with VSD) allowed from Jan 2015 (motors >7.5 kW)
  - > Extended to motors > 0.75 kW in Jan 2017
  - > All EC motors already meet the IE3 standard
- Carbon Reduction Commitment (CRC)
- Enhanced Capital Allowances (ECA)
  - > Permanent Magnet Motors (EC category) qualify for ECAs

Energy saving through EC Fan Technology

OPPORTUNITIES

Opportunities

- The use of EC technology presents several opportunities
  - > Reduction in energy usage
  - > Reduction in noise
  - > Simpler control
  - > Constant monitoring
  - > Reduced maintenance
  - > Lower life cycle cost
  - > Improved Building Performance Certificate
  - > Reduction of CRC liabilities
  - > Improved asset value
  - > In fact, a programme of fan replacement can make significant savings in the medium to long term

Energy saving through EC Fan Technology

SUMMARY

Energy Savings

- Specification or replacement of fan technologies within the Built Environment can have a significant impact upon energy usage and the carbon footprint of a building
- Savings of up to 70% can be achieved through the use of EC technology
- Provides simple but complete electronically controlled package,
- Resulting in reduced wiring and fewer supplementary devices
- Higher efficiency means less waste heat and increased bearing life
- Resulting in lower energy bills, reduced maintenance and lower whole life costs

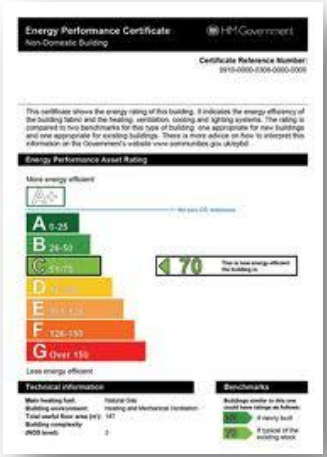
Replacement of existing AC fans

- EC fans provide like for like replacement of existing fans
- Simple to replace and install across a wide range of applications including
  - > Heating
  - > Ventilation
  - > Air conditioning
  - > Refrigeration
  - > Humidification
  - > Controlled environment applications

- Replacement payback in as little as 2 years (energy saving versus capital cost)

EPC Ratings and CRC Obligations

- Within new buildings the specification of EC technology enables the system provider to incorporate advanced control and monitoring features into their product
- The inclusion of EC technology will help to improve the energy efficiency of the building and thus aid in gaining an improved Energy Performance Certificate
- Higher EPC ratings mean asset values are also improved
- Energy savings through retrofit or upgrade will help building occupiers to meet their CRC obligations



Summary - Learning Outcomes

- Understanding of AC and DC fan technology
- Understanding of EC technology
- How the technologies compare
- How this impacts upon energy efficiencies
- How this can impact upon the Built Environment
- Relevance of current and future regulations
- Opportunities presented by EC technology

Energy saving through EC Fan Technology

ANY QUESTIONS?