Electronically Commutated (EC) Motors

Introduction

On October 31 2017, Ziehl-Abegg, a corporate member of EmiratesGBC, delivered a Technical Workshop which discussed the workings of Asynchronous (AC), Direct Current (DC) and Electronically Commutated (EC) motors. The workshop was facilitated by Dipen Patel and David Miller who elaborated on the components of EC motors, the differences between EC Motors and AC Motors and the advantages they offer, particularly in HVAC/R systems.

Motors

Motors are used to convert electrical into mechanical energy. When current is passed through a set of windings (coil of wire) within a motor, the windings are energized and a magnetic field is created. Motors are used typically to drive in HVAC/R systems in buildings and account for an estimated 8-9% of global electricity consumption. However, this figure is expected to be much higher in the Middle East as HVAC use in the region dominates energy use in buildings.

AC Motors

Asynchronous (AC) Motors are the most common types of motors used and consists of two basic parts: The Stator (Outside) and Rotor (Inside). The stator is the non-moving static component of the motor and is supplied with a current to produce a rotating magnetic field. The rotor is the moving/ rotating component of the motor and also carries a current that results in a magnetic field. The magnetic fields between the two components interact and produce a rotational movement. These motors rely and operate on a small difference in speed called 'slip' between the two components. A key point of AC motors is that they are designed to operate at a specific peak

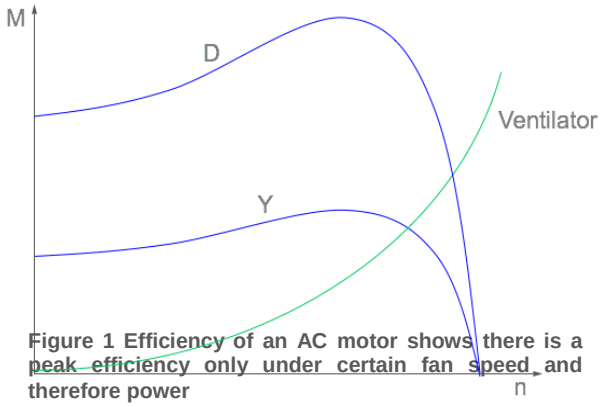

Figure 1 Efficiency of an AC motor shows there is a peak efficiency only under certain fan speed and therefore power

efficiency, which drops considerably at either side of the optimum operating point as shown in Figure 1.

DC Motors

DC Motors also consist of the stator and the rotor, with the difference being that the magnetic field of the stator is generated by a permanent magnet, which results in a synchronous rotation of both the stator and rotor, therefore there is no slip. Another difference is that basic DC motors rely on carbon brushes and a commutation ring to switch the current direction, and therefore the magnetic field polarity, in a rotating armature. The interaction between this internal rotor and fixed permanent magnets induces its rotation. The friction between the carbon brushes and rotor generates considerable heat and is liable to wear and breakdown.

EC Motors

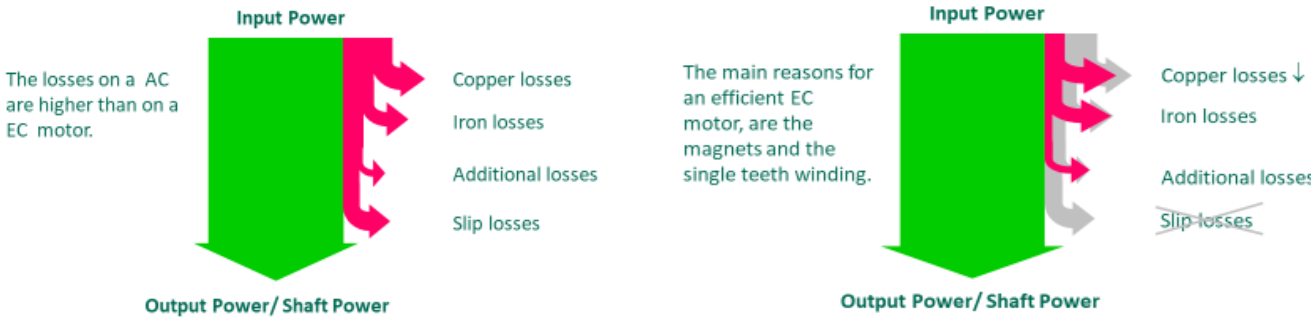

Figure 2 Power losses of an AC Motor (left) compared to the power losses of an EC Motor (right).

EC Motors are DC brushless motors that are controlled by an external electronic circuit board. It simplifies the workings of the motor so that there are fewer losses in the system and thus increases the efficiency of the system. The electronics function is the same concept as dampers and actuators whereby changing the voltage signal to the motor changes the speed of the motor giving greater control of the speed of motor. EC Motors can also be integrated to a Building Management System (BMS) and some larger motors can be adapted to communicate through a number of different TCP/IPs.

The key advantage as shown in Figure 2, shows that the efficiency of the EC Motors is higher due to relatively simple components. This also ensures longevity of the motor as there are no physical contacts through brushes. Furthermore, encapsulation of the electronics of the EC Motor offers significant protection against a number of environmental conditions such as water, humidity, dust and

vibration. In built cooling ensures that electronics do not overheat, and thus EC Motors are expected to last significantly long periods of time (~20 years) whilst maintaining their efficiency.

Group Discussions

The group discussions outlined the three key factors: Integrated Power Electronics, Outstanding Efficiency, Simple Controls of EC Motors and its use for majority of applications. The Integrated Power Electronics not only offers efficient motor speed control but also has the advantage that there is no additional speed control component such as Variable Frequency Drive (VFD) as it is incorporated within the motor. This eliminates the need for additional wiring between the controller and motor, thus simplifying the HVAC system. The inbuilt temperature regulation, overcurrent protection and EMC filters, increases the safety and reliability of EC Motors.

The Outstanding Efficiency discussion showed that, even at partial loads, EC Motors perform better than AC motors as shown in Figure 3. EC motors achieve a motor efficiency rating of IE4. Generally speaking, replacing AC motors with EC Motors can result in 30% year-on-year energy savings, reduce the size footprint, and reduce the operating noise of the HVAC system.

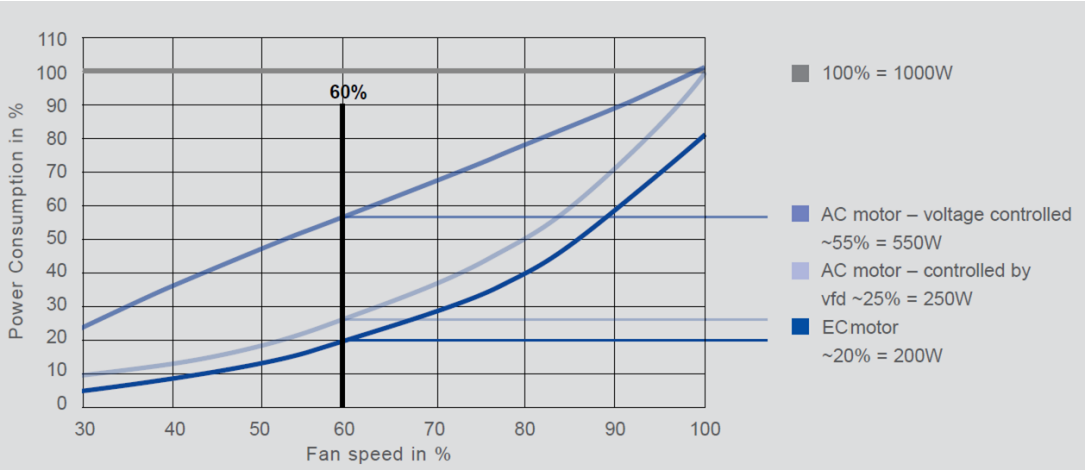

Figure 3 shows that an EC motor consumes less power than AC motors whilst operating even at 20% fan speed.

Simple Speed Control using 0 – 10V signal and option of integration with BMS networks for control and feedback simplifies how traditional HVAC systems operate and provides more flexibility and control to the user with multiple control options. An interesting concept of incorporating in-built memory within the electronics was also discussed, which was further elaborated to highlight that upcoming EC Motors can be connected to mobile Apps to monitor the status of the motor. This shows that there is

still potential to innovate EC Motors so that they can communicate wirelessly and therefore contribute to the development of the Internet of Things (IoT) and smart buildings.

Conclusion

The UAE aims to be a global leader in sustainability though the UAE Vision 2021 and its National Agenda and therefore a number of local strategies have been developed to support this. An example of this is Dubai's Demand Side Management (DSM) Strategy that aims to reduce energy and water consumption in Dubai by 30% by 2030, which places an emphasis on increasing energy efficiency of buildings. As HVAC/R systems contribute significantly to the energy consumption of buildings, it becomes necessary to implement energy efficient motors used for HVAC/R systems so that they can improve the overall energy efficiency of the buildings. The use of EC Motors can facilitate such an improvement as their use offers numerous advantages over traditional motors.