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ECM Motors: An Energy Saving Opportunity

Introduction

Achieving high energy saving is a mandate for all federal government facilities (Executive Order 13693) to reduce carbon emission. This requires the exploration of all opportunities to save energy including the power consumptions of small motors. Utilizing high efficiency small motors offers the greatest power saving opportunity today as most of these currently operating motors have very low efficiency.

History and Basics

Most small motors, commonly found in air handlers, air conditioners and refrigeration applications, are Permanent Split Capacitor (PSC) induction type. PSC motors have two sets of windings and have a permanent capacitor in one of the windings to create current lag between the two. Both windings are energized during motor starting and running conditions.

Electronically Commutated Motors (ECMs), which were initially listed in HVAC literature as Integrally Controlled Motors (ICMs), use brushless DC permanent magnet. ECMs are essentially DC motors that uses built-in inverter, which converts AC current to DC current, to create stator field and permanent magnet rotor. As these motors do not need to use power to create rotor field, they provide better performance over PSC motors. In addition, ECMs offer greater controllability.

Benefits

ECMs are controlled electronically by a microprocessor and electronic controls and offer higher electrical efficiency while providing the ability to program precise speed of the motor. Combining electronic controls with brushless DC motors, ECMs can maintain efficiency across a wide range of operating speed. ECMs are available in different sizes from fractional Horsepower (HP) up to 10 HP, depending on the manufacturer.

Figure No.1 ECM Motor and Control

For HVAC applications, ECMs offer higher efficiency than conventional PSC induction motors. ECMs also offer higher efficiency, precise and unlimited airflow selection (variable speed) in fans, and properly maintained airflow during changes in system static pressure (constant airflow). Although ECMs can be found in Variable Air Volume (VAV) fan powered air terminals, fan-coil units are often overlooked by energy conservation professionals because of their low power consumptions. However, in a typical building, there are usually many fan-coil units that use PSC motors, offering a great opportunity to save energy by replacing them with ECMs. In addition to energy saving, ECM installation may qualify for energy rebate and satisfy green building initiative.

Evaluation of ECM Key Characteristics

There are distinct characteristics that should be considered when considering ECMs (Figures No.1 and No.2), versus PSC motors (Figure No.3) for new installations or retrofits.

ECM

- Limited Horsepower - 1/60 HP to 4 HP is the typical range. (1 HP is by far the most common size as these motors have been used extensively in residential furnace/air handler applications for more than 20 years.)
- Used mostly for direct drive applications.
- Quiet. The soft start characteristics of ECMs allow them to operate without the torque-start noise that is typically associated with induction motors.
- ECMs have wider operating range compared to traditional induction motors allowing one ECM to replace a number of induction motors.
- High Efficiency. Efficiency greater that 90% is common.

Figure No.2 ECM Motor with Integral Control

PSC Motors

- PSC motor (HVAC blowers and fans 0.25 to 1 HP) efficiency, when operating at full load, ranges from 55% to 65%. Lightly loaded PSC motors are significantly less efficient and most PSC motors are over-sized in order to allow for flexibility in application.
- Increased heat generation due to low motor efficiency. Excess heat is generated since a significant portion of the input energy is not translated into actual work. This excess heat generation by the PSC motor adds to the building cooling load.

Figure No.3 PSC Motor

Conclusion

ECMs, in HVAC applications, can decrease energy usage by as much as 75%. ECMs require less maintenance and are not prone to overheating. Depending on the application, ECMs can offer shorter payback compared to PSC motors.

References and Further Reading

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