ABB DRIVES AND MOTORS

30 top tips to tackle HVAC challenges

No.03 - Permanent magnet motors

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Not all motor technology is suitable for HVAC. How about permanent magnet motors?

Permanent magnet (PM) motors may be used to achieve the Ecodesign Directive for efficiency, and achieve the specific fan powers required by your installation. However, the technology may not be suitable for all HVAC applications.

Find out why by clicking on the tabs below.

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Technical

Specific fan power (SFP)
SFP is a measure of how much electric power is required by a fan to move a given air volume. The SFP is influenced by flow rate, resistance of the ventilation system and efficiency of the fan system. By stipulating a maximum SFP, it is possible to limit the power requirements for transporting air throughout an entire building, air handling units (AHUs) and individual fans.

To meet the requirements of the SFP as stipulated in Part L of the building regulations a system design is needed. The HVAC market generally recognises four electric motor types:

- Brushless DC motor, or electronically commutated motor (ECM).
- Synchronous reluctance motor (SynRM) together with variable speed drive (VSD).
- Conventional fan controlled by conventional induction motor (IM) and VSD.
- Permanent magnet (PM) motor.
  In this tip we will consider PM motors.

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Technical

Permanent magnet (PM) motor
PM motors are expensive, difficult to handle (they magnetise themselves to any ferrous surface), have non-standard motor shapes and fixing dimensions and generate dangerous back EMF voltages when freewheeling.

This latter challenge means that the common practice of opening a motor isolator to perform maintenance is no longer adequate. The fan shaft needs to be locked in place to avoid electric shock.

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Technical

Permanent magnet motors

Advantages

- Permanent magnets mean no generation of a “second magnet” in the motor, so losses and absence of heat due to current in the rotor means the motor is more efficient, hence considered for HVAC.
- 30-60 percent higher torque capacity and 30 percent better torque utilisation with faster acceleration and deceleration compared to IMs.
- Compact design in non-standard frames with high torque density and less weight that fit into smaller spaces.
- Higher operational efficiencies with no magnetizing currents.

Advantages – not applicable to HVAC applications

- Absence of “slip” makes PM motor more responsive.
- Higher continuous torque over a wide range of speeds.
- Lower rotor inertia, higher dynamics.
- Higher dynamic performance under load.

Technical

Permanent magnet motors

Disadvantages

- PMs are often up to three times the price of IMs.
- Can be hard to maintain and operate as PMs on the rotor make the rotor hard to extract.
- The magnets can be attracted to nearby equipment such as lifting or handling machinery and even the air handling units (AHUs).
- Often de-magnetise over time.
- Not possible to overspeed PM motors to achieve best efficiency characteristics of the system.
- Do not have standard IEC frame sizes, meaning that AHUs need to be mechanically re-designed.
- Generate electricity in a freewheeling load situation making them dangerous to work on, causing electric shock or death. The HVAC practice of isolating will not protect from this, as the voltage is in the terminal box.
- Best efficiency point is near top speed, so when controlling HVAC applications across a speed range, the efficiency drops.
- Drive motor control in the VSD has to be good for reasonable control of the fan or pump. As such, encoder feedback is often required.

Frequently Asked Questions

Are PMs easy to maintain?
No – the magnets make removing the rotor extremely difficult, and returning it to the motor even harder.

Are PMs expensive?
Yes – PM motors are typically up to three times more expensive than an equivalent IM or SynRM.

Do PMs generate voltages from a spinning load?
Yes – the magnets mean that the motor will generate electricity even with the motor isolator open.

Do you need a variable speed to control it?
Yes – PM motors require a VSD, and sometimes an encoder.

Do they achieve specific fan powers?
Yes – because there are no rotor losses, they are quite efficient.

Hints

The HVAC industry has a practice to isolate near to the motor to make it safe for a mechanical operator to work on an air handling unit (AHU). With a PM motor this isolator is ineffective. A spinning motor will generate dangerous voltages within the terminal box.

The only way to avoid electric shock from this regenerative energy is to mechanically lock the rotor during maintenance, yet this is not always possible.

PM motors need a variable speed drive (VSD) to operate them. The controller will achieve a control point that saves energy, and the drive can be connected to fieldbuses and building management systems. Sometimes encoders are required, depending on the VSD being used.

This is one of 30 top tips for users of variable speed drives in heating, ventilation and air conditioning applications. To ensure that you receive ALL the tips as they are published, please register your interest by **clicking here**

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