Drive^{IT} Low Voltage Permanent Magnet Motors for low speed applications

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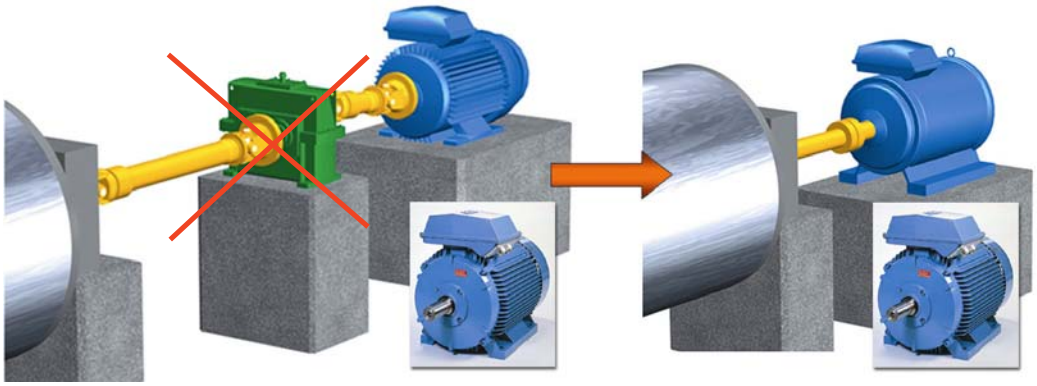
Technical Notes



What is the Drive^{IT} low voltage permanent magnet motor?

The low voltage permanent magnet motor is a new type of synchronous motor for low speed applications, for use with variable speed drives.

Mechanically, the motor type is similar to the traditional, induction, totally enclosed squirrel cage motor; even their outward appearance is same. However, in performance terms, it matches the accuracy of the traditional synchronous motor.

What is the construction and design of the permanent magnet motor?

The synchronous motor is traditionally of a more complex construction than the standard induction motor. With the new motor type, the design has been simplified by using powerful permanent magnets to create a constant flux in the air gap, thereby eliminating the need for the rotor windings and brushes normally used for excitation in synchronous motors. This results in the accurate performance of a synchronous motor, combined with the robust design of a standard induction motor. The motor is energized directly on the stator by the variable speed drive.

What are the benefits of using permanent magnet motors ?

Standard induction motors are not particularly well suited for low-speed operation as their efficiency drops with the reduction in speed. They may also be unable to deliver sufficiently smooth torque across the lower speed range.

This is normally overcome by using a gearbox. The new solution provides a high torque drive coupled directly to the load. By eliminating the gearbox, the user saves space and installation costs, as he only needs to prepare the foundations for one piece of machinery. This also gives more freedom in the layout design.

The synchronous motor can deliver more power from a smaller unit. For instance, powering the in-drives of a paper machine directly at 220 to 600 r/min with a conventional induction motor would require a motor frame substantially larger than that of a 1500 r/min motor. Using permanent magnet motors also means higher overall efficiency and less maintenance.

The combination of fewer components and simpler configuration reduces plant engineering hours, facilitates installation, allows more efficient use of floor space and reduces spare part inventories.

In the case of a paper machine, the Drive^{IT} Direct Drive Solution will consist of a number of permanent magnet motors, controlled by a Drive^{IT} low voltage AC drive based on ABB's ACS 600/800 frequency converter. The Drive^{IT} Direct Drive Solution improves drive controllability, enabling the paper machine drive to run without a pulse encoder, as synchronized motors allow very exact control without feedback. The accuracy is as good as that of an induction motor in variable speed operation with a feedback device. This means the pulse encoder can be eliminated, further reducing the need for maintenance.

The permanent magnet motor is a further development of the synchronous motor, combining the high accuracy of this motor type with the robust design of an induction motor. It is able of delivering very high torque from a small motor size at low speed, eliminating the need for gearboxes. The permanent magnet motor requires frequency converter supply. ABB's frequency converters have been specifically modified to operate with permanent magnet motors.

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This is particularly beneficial in the paper industry, where poor reliability of feedback devices contributes to production stoppages. It can also reduce design complexity, as the feedback devices sometimes can be difficult to integrate in the system or have to be positioned in places that are difficult to reach.

What are the suitable applications?

The permanent magnet synchronous motor is ideally suited for paper machine drives, eliminating the need for gearboxes and pulse encoders. On a recent installation, 29 of these motors were used, helping to improve the reliability and the control accuracy of the drive system. However, permanent magnet motors can be used in any application, where a squirrel cage motors with a gearbox would normally be used.

What are the special characteristics of the permanent magnet motor?

The permanent magnet motor is designed exclusively for frequency converter supply. It is not suitable for direct-on-line operation. Furthermore, the motor's internal voltage is affected by the motor speed, due to the constant flux of the permanent magnets. For this reason, overspeed is limited to 20 %. Higher speed increases the voltage, which could damage the supply and the motor insulation.

The catalogue data is only applicable with the specified network voltage; e.g. 400 V data is not valid for 380 V or 415 V networks. The motors can be used at various voltage levels but the speed and output will vary.

A 20-30% margin between the required torque and motor break down torque will always be required, as the break down torque is lower than with squirrel cage motors. In practice, this means the motors have very limited short time overload capacity.

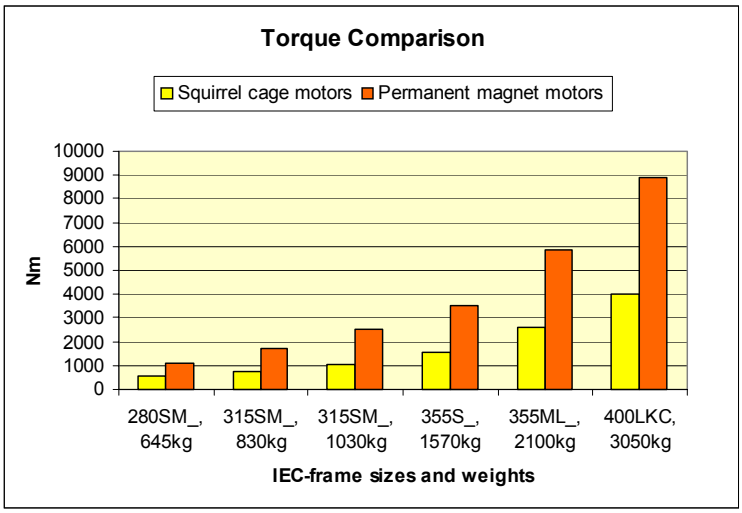
Strong magnetic flux is present in the motor even if the stator windings are not energized. When the motor is rotated by the shaft, voltage will be generated at the terminals.

Due to the fact that the rotor is continuously magnetized, the motor cannot be removed as easily as a standard induction motor. Tools are however available in case this becomes necessary. Routine maintenance, for instance bearing replacement, can be carried out by opening the motor the same way as a standard squirrel cage motor.

Can any frequency converter control the permanent magnet motors?

The permanent magnet motors can only be controlled with a variable speed drive. Furthermore, the synchronous motor control software must be specifically developed for permanent magnet flux control.

ABB's Direct Torque Control method, used in ACS 600/800 frequency converter, has been further developed to achieve this. The motor control can use the same inverter hardware as the induction motor control and be cooled by air or water.



What is the motor range?

The speed and output of a permanent magnet motor are as follows;
0 - 220 r/min, 17 -1120 kW at 220 r/min
0 - 300 r/min, 25 -1600 kW at 300 r/min
0 - 430 r/min, 38 - 2240 kW at 430 r/min
0 - 600 r/min, 57 - 2500 kW at 600 r/min

The output and speed values apply for 400 V/690 V networks. Available in IEC-frame sizes 280 to 560.