Frequently Asked Questions

1. What class of motors does the NovaTorque™ motor belong?

The NovaTorque motor is an "electronically commutated permanent magnet" (ECPM) motor. It can also be correctly termed a "permanent magnet AC" (PMAC) motor.

2. What are the generic advantages of Permanent Magnet (PM) motors when compared with AC induction motors? Disadvantages?

As with all permanent magnet (PM) motors, the NovaTorque motor enjoys the following advantages and disadvantages when compared to AC induction motors.

Advantages

PM motors are inherently more energy efficient than induction motors. In an induction motor the rotor's magnetic field is generated by an electric current. In a PM motor the rotor's magnetic field is produced by permanent magnets. The fact that the rotor's magnetic field need not be electrically produced reduces the electrical energy required. Other unique features of the NovaTorque design discussed below further reduce the electrical energy required, resulting in a more efficient motor even than other PM designs.

The power density of a PM motor is greater than that of an induction motor. Permanent magnet motors of the same physical size as an induction motor will typically produce more power. This means that a permanent magnet motor of the same power as an induction motor may be a frame size smaller and in many cases can support a higher service factor than the induction motor.

In many configurations, particularly with low speed motors the NovaTorque motor will have a lower FLA (full load amps) requirement. In some cases this advantage may allow the use of a smaller drive than the equivalent induction motor.

PM motors deliver high continuous torque over their entire speed range. In contrast the continuous torque available from an induction motor decreases significantly at lower speeds. The PM motor's ability to continuously deliver high torque at low speed, along with its high power density (that is, its ability to produce more power in the same package size) may, in many applications, eliminate the need for gearing or other mechanical transmission devices. Eliminating gearboxes or other mechanical transmissions reduces the energy losses associated with those components, reduces the space required, reduces necessary maintenance, increases reliability, and eliminates the cost of the unnecessary mechanical components.

Disadvantages

Conventional PM motors are more expensive than induction motors. Conventional PM integral horsepower motors typically require the use of rare earth magnets. However, the NovaTorque motor's unique geometry focuses the flux produced by the permanent magnets, allowing the use of readily available and lower cost ferrite magnets.

PM motors require external commutation to rotate. Unlike induction motors, a PM motor cannot be operated directly across the line. A VFD (Variable Frequency Drive) is required for commutation. However, because of the energy savings associated with running a motor at lower speeds when possible in HVAC or pump applications the use of VFDs is becoming much more common. NovaTorque motors will be most cost effective in applications requiring or benefiting from the ability to vary the speed of the motor.

3. How is the NovaTorque motor design different from conventional PM motors? What are the NovaTorque motor's advantages and disadvantages compared to conventional PM motors?

NovaTorque motors have an axial, rather than radial design, common with many other PM motors. This enables NovaTorque motors to have a very compact bobbin-type electrical winding. Unlike conventional radial motors there are no end turns. All of the wound conductor in a NovaTorque motor is used effectively. This results in a lower winding resistance than radial motors, and therefore lower resistive (I^2R) losses. At low speeds, resistive losses dominate. Since NovaTorque motors have less resistive loss than radial motors, low speed efficiencies are higher.

The NovaTorque motor's unique rotor geometry results in greater flux concentration than in typical PM motors. The unique rotor design and conical geometry results in more concentrated flux at the field pole, allowing for the use of readily available, low cost ferrite magnets. This, among other innovations, allows the NovaTorque motor to deliver PM performance at prices more comparable to induction motors. The flux path in a NovaTorque motor is axial versus radial. The magnetic flux path in a NovaTorque motor is transmitted axially (parallel to the shaft) across the rotor hubs through the stator (versus the radial flux paths in a more conventional PM motor), enabling the use of grain oriented steel for the stator poles. This means the flux transmission through the field poles is much more efficient than with other motor designs. The core losses in a NovaTorque motor are as much as 75% lower than in a radial motor.

The magnets are mounted within (interior to) the rotor structure resulting in improved motor performance and integrity. In an IPM motor, the magnets are embedded within the rotor structure and mechanically restrained. This is a more reliable, higher performing arrangement than surface adhesion of magnets as is done in many conventional PM motors. Interior permanent magnets also result in increased saliency. Increased saliency generates more accurate speed control and allows the motor to operate over a greater speed range before requiring external position sensors.

The motor geometry improves heat dissipation efficiency. Because the coil surface directly faces the outside of the stator, heat is more easily dissipated, resulting in cooler motor operation, extending motor life.

NovaTorque motors are priced lower than conventional PM motors. The NovaTorque motor was designed to compete effectively with induction motors – not simply to compete with other PM motors.

Disadvantages

The NovaTorque motor's rotor inertia is greater than is generally the case in conventional PM motors. While this is actually an advantage in many applications, it would be a disadvantage in high acceleration/deceleration servo positioning applications.

4. What are the advantages of the NovaTorque motor versus an induction motor? Disadvantages? Much of the following is a repeat from the answers to questions #2 and #3 above. Most of the advantages of the NovaTorque motor compared with an induction motor are further improvements on the advantage generic to PM motors.

Advantages

The NovaTorque motor is significantly more efficient than even NEMA Premium efficiency induction motors, and the advantage increases substantially when the motor is operated below rated speed. The NovaTorque efficiency advantage over induction motors is more than 3 points for a 10 hp, 1800 RPM motor, and as much as 10 points or more for a low speed (900 RPM motor)

Because the efficiency curve of the NovaTorque motor is flatter than an induction motor (which becomes significantly less efficient as the load decreases), the NovaTorque efficiency advantage increases substantially in variable torque, variable speed applications such as fans. For example, when operating at half the rated speed of the motor, the NovaTorque™ motor 10 hp, 1800 RPM motor will be approximately 10 percentage points more efficient than a NEMA Premium motor.

NovaTorque™ motors typically a rapid payback compared to NEMA Premium efficiency induction motors. Approximately 97% of the cost of ownership of an industrial use electric motor is the energy it consumes. Only 3% is the actual purchase price. Because NovaTorque motor are priced at a relatively small premium to NEMA Premium efficiency induction motors, and because they provide significantly greater efficiency and do so over a wide speed range, the payback on the initial price premium between a NovaTorque motor and a NEMA Premium efficiency induction motor may be as little as 1 to 2 years. (Payback varies based on duty cycle, local cost of energy, operating range, etc.)

The NovaTorque motor provides high continuous torque capability over its entire speed range. As noted earlier, the continuous torque available from an induction motor declines significantly as speed is decreased. The ability of the NovaTorque motor to economically produce higher continuous torque at low speed may eliminate existing application issues and/or result in the ability to eliminate the necessity for gearing or belts.

NovaTorque motor's design improves both efficiency (less heat generated due to losses) and dissipation (for the heat that is generated), resulting in cooler operation when compared to induction motors, therefore increasing reliability and extending the motor's life.

The geometry of a NovaTorque motor results in high power density (same power in a more compact package).

Disadvantages

The initial purchase price of a NovaTorque motor is higher than a NEMA Premium efficiency induction motor. When only initial purchase cost (versus the ongoing cost of ownership) is a consideration, the NovaTorque motor may be disadvantaged. But when lifetime cost of ownership, or even the first few months or years of ownership is taken into account the NovaTorque motor advantage is decisive.

NovaTorque™ motors require a drive. As a result, in constant speed applications the additional cost of the drive, plus the price premium for the motor, may yield unacceptable paybacks. For this reason, NovaTorque motors are targeted only for those applications in which variable speed is needed.

5. How do NovaTorque™ motors achieve better low speed efficiency when compared to either induction or conventional radial PM motors?

NovaTorque motors have an axial, rather than a radial design which is more common with many other PM motors. This enables NovaTorque motors to have a very compact bobbin-type electrical winding. Unlike conventional radial motors there are no end turns. All of the wound conductor in a NovaTorque motor is used effectively. This results in a lower winding resistance than radial motors, and therefore lower resistive (I^2R) losses. At low speeds, resistive losses dominate. Since NovaTorque motors have less resistive loss than radial motors, low speed efficiencies are higher.

The flux path in a NovaTorque motor is axial versus radial. The magnetic flux path in a NovaTorque motor is transmitted axially (parallel to the shaft) across the rotor hubs through the stator (versus the curved radial flux paths in a more conventional PM motor), enabling the use of grain oriented steel for the stator poles. This means the flux transmission through the field poles is much more efficient than with other motor designs. The core losses in a NovaTorque motor are as much as 75% lower than in a radial motor.

6. How does the NovaTorque motor achieve its continuous torque advantage at low speed? On what applications would this be important? Again, this advantage is generic to PM motors when compared to induction motors.

As stated earlier, induction motors will overheat and eventually fail in high torque, low speed conditions due to very high losses (inefficiencies) when the motor is operated at low speed. For this reason, gearing is often employed to produce low speed at the load while maintaining higher speed at the motor. Gearing, however, introduces new inefficiencies, as well as additional cost, complexity, maintenance, and space requirements.

It should be noted that selection and proper tuning of the VFD is particularly important in high torque, low speed, open loop applications. One's drive provider or the NovaTorque motor's application engineering department can provide guidance in this regard.

High torque, low speed operation can be important in variable-speed mixing, grinding, or material transport applications.

7. How does the NovaTorque motor price compare with NEMA Premium efficiency induction motors? With commercially available PM motors?

The NovaTorque™ motor's innovative design and construction has allowed Marathon Motors to establish pricing at levels more comparable to NEMA Premium efficiency induction motors than to commercially available PM motors.

8. How long is the "payback" on the NovaTorque™ motor's price premium over NEMA Premium induction motors?

Several factors determine the number of months of energy cost savings needed to repay the additional investment (price premium) for the NovaTorque motor to provide a precise answer.

Those factors include the cost of electricity ($/kwh), utility demand charges or other penalties, the number of hours of operation, the speed at which the motor operates, the relative efficiencies of the alternative motors, and the delta in motor pricing.

Typically, however, the payback will work out to 12 to 24 months, or less, returning 15 to 20 times the price premium over the life of the motor.

9. Many HVAC motors are mounted outdoors/rooftop. How "weatherproof" is the NovaTorque motor? Temperature constraints?

NovaTorque™ motors are totally enclosed with ingress protection up to IP54 available. They are dust-protected and resistant to water splashes, but are not intended for wash-down or exposure to direct rain. Covered outdoor use is clearly acceptable. Consult factory for use as condenser motors in open air, shaft-up orientation. Ambient temperature service conditions are -10 °C to 40 °C (14 °F to 104 °F).

10.How is the reliability of the motor assured?

All production motors are subjected to a series of tests prior to shipment.

Importantly, reliability has been a central design theme, with many failure modes, common to the motor industry designed out. Most of those failure modes are heat-related bearing or winding issues. The high operating efficiency of the NovaTorque motor reduces heating due to losses, allowing the motor to run cooler, hence inherently improving reliability. Additionally, as the coils are adjacent to the case of the motor, what heat is produced is dissipated more efficiently, further reducing the operating temperature of the motor.

The electrical wind of the NovaTorque motor is a compact bobbin-type with no end-turns. The simple nature of the winding improves reliability, as less stress is placed on the wire conductor during the winding operation when compared with a conventional ‘stitch wound’ motor.

The magnets used in the NovaTorque motor are mechanically restrained. This ensures that no motor failures will result due to magnet de-lamination as can occur in with surface mount magnets in conventional PM motor designs.

11.What type of magnets does NovaTorque motor use? Is demagnetization a potential problem?

Due to the flux concentration produced by the geometry of the NovaTorque motor, the motor produces rare-earth-like performance with the use of ceramic ferrite magnets. Ceramic ferrite magnets are readily available and lower in cost than rare earth magnets. Also unlike rare earth magnets, they are NOT subject to demagnetization at high temperature. They are susceptible to demagnetization at very low temperatures (below -20 degrees C) if full power is applied when at that temperature. That issue is easily remedied by limiting power to the motor until it reaches safe operating temperature.

12. Does the NovaTorque™ motor meet NEMA Premium and IE3 standards? Yes, and then some! The IEC (International Electrotechnical Commission) has established standard categories/designations for various levels of electric motor efficiency. They range from IE1 to IE4. IE1 designates “Standard Efficiency”. IE2 designates “High Efficiency”. IE3 designates “Premium Efficiency” and IE4 designates “Super Premium”.

IE3 and “NEMA Premium” are essentially the same, with small differences at a few sizes (HP). NEMA Premium is mandated in the US as of Dec 19, 2010. IE3 or IE2 with a VFD is required in Europe as of January 1, 2015.

IE4 has been defined by the IEC as a 15% reduction in motor losses from the IE3 standard. IE4 motors are higher priced than IE3 motors, and are typically made with permanent magnets.

IE5’s Ultra-Premium efficiency standard has been proposed as a 20% reduction in losses from IE4.

NovaTorque motors already exceed the proposed IE5 efficiency rating!

13. Are VFD induced shaft voltages an issue with the NT motor? If so, what protective measures should be employed?

It is recommended that all motors operating on a VFD employ protection against the discharge of shaft voltages through the bearings. NovaTorque motors are shipped with a shaft grounding mechanism as a standard option.

14. How is the motor commutated? Is a sensor required?

The NovaTorque motor is electronically commutated using the back EMF of the motor for determining rotor position. No sensor is required. Variable Frequency Drives (VFDs) that support permanent magnet motors have this feature built into their algorithms. Most major suppliers offer drives that support both induction motors and permanent magnet motors. Contact NovaTorque motor Application Engineering for a list of drives that have been tested and approved with the NovaTorque motor.

15. Can the motor be run across the line?

No. A drive is required for the motor to operate, and it cannot be bypassed.

16. Is the NovaTorque UL listed?

All NovaTorque motors are UL Recognized components, with authorization to apply the UL Mark.

This certification mark indicates that the product has been tested to and has met the minimum requirements of a widely recognized (consensus) U.S. product safety standard, that the manufacturing site has been audited, and that the applicant has agreed to a program of periodic factory follow-up inspections to verify continued conformance.

17.What is the history of the NovaTorque® technology?

The NovaTorque company was founded in 2005 in California. The NovaTorque technology was purchased by Regal Beloit America, Inc. in late 2016. The NovaTorque technology has been utilized in the NovaTorque motor and branded under Marathon Motors.

18. What is Marathon Motor's NovaTorque motor launch schedule?

Marathon Motor's goal is to offer the NovaTorque motor 3 – 20 hp at 1800 RPM:

213T/215T and 182T/184T – End of 2nd quarter 2017

254T/256T – End of 4th quarter 2017

19. What applications benefit most from the NovaTorque motor's advantages and why?

The NovaTorque motor efficiency curve is both higher and flatter than induction motors. Hence, variable torque applications with wide speed and load requirements, such as fans and pumps, benefit significantly from the improved efficiency. A study commissioned by an electric utility, concluded that the NovaTorque motor would use 7 to 22% less power than a NEMA Premium motor when used in a fan application with a typical load profile.

The NovaTorque™ motor is also capable of producing high continuous torque at low speeds without overheating. Thus it is well suited for applications characterized by the need of constant torque over a wide speed range. Mixers would be an example. Treadmills would be another.

The high continuous torque and the high power density together will often eliminate the need for gearing, allowing the load to be driven directly. Many applications (example: conveyors) would benefit from the reduction in mechanical complexity, cost, inefficiency, and maintenance.

20. Where can I purchase a NovaTorque motor?

NovaTorque motors are available through Marathon Motor's® distributor network as well as contacting the team directly through the contact form on the web site or through novamax@regalbeloit.com.

21. What kind of technical and/or sales support is available for the NovaTorque™ motor?

The NovaTorque motor's application engineering team is available to our OEM customers for pre and post-sale technical assistance. As customer technical support requirements typically relate primarily to the drive component of the system, support is usually best first solicited directly from the drive manufacturer.