

BAUER GEAR MOTOR™

Understanding the Role of Permanent Magnet Synchronous Motors (PMSM) in Modern Industrial Drive Systems



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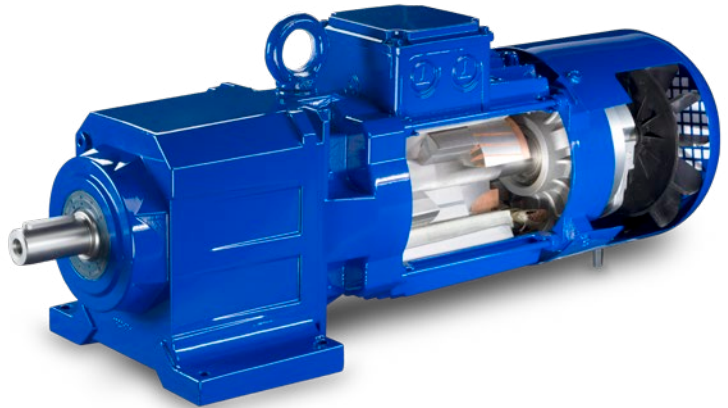
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Understanding the Role of Permanent Magnet Synchronous Motors (PMSM) in Modern Industrial Drive Systems

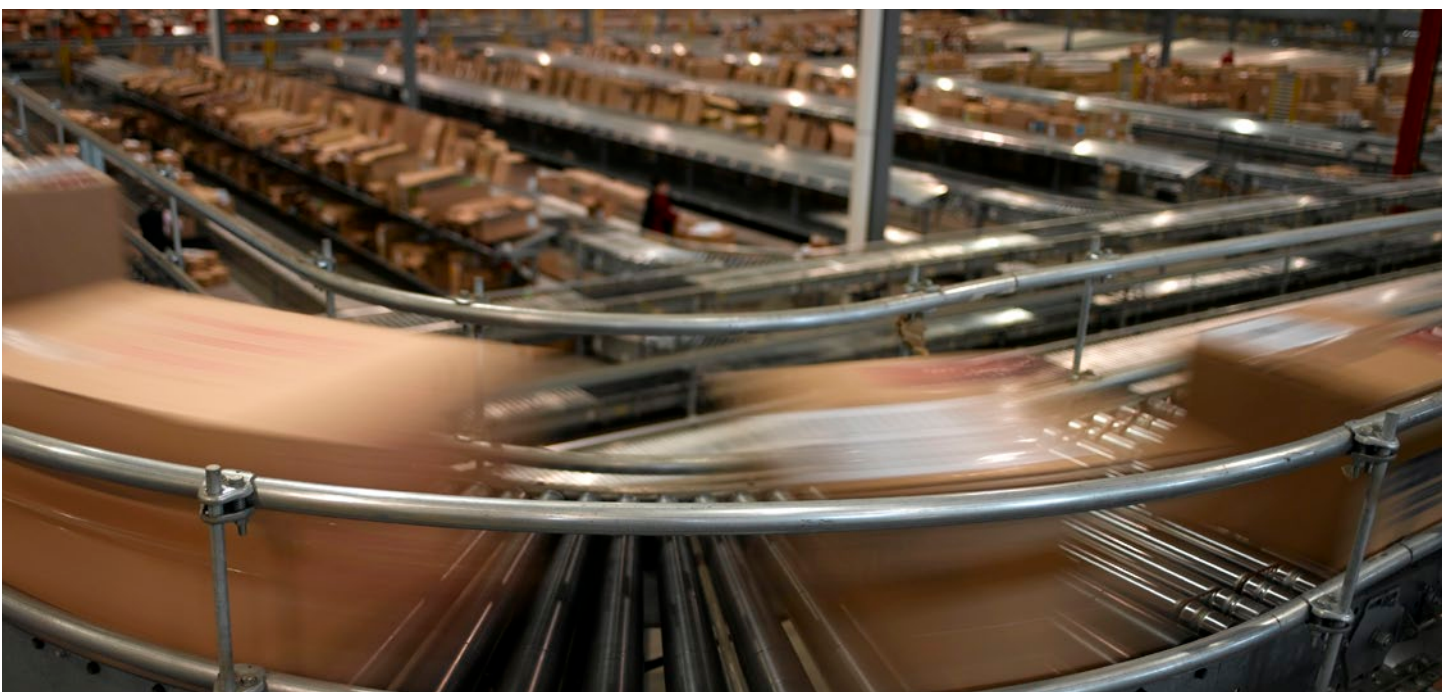
The Permanent Magnet Synchronous Motors (PMSM)—also referred to in certain markets as Permanent Magnet Alternating Current (PMAC) motors—have seen a significant rise in their adoption as the industry standard in recent years. They have been viewed as a practical and mature solution for industrial applications where efficiency, controllability, and system-level optimization are prioritized in addition to exceeding industry-wide energy standards.

The true benefit of PMSM gear motors emerges when the technology is evaluated within the context of true-to-life operational environments and system strategies. Examining PMSM gear motors through the lens of application behavior and day-to-day demands reveals how their true strengths align with modern industrial needs such as efficiency, flexibility, and long-term optimization by variance and inventory reduction. This perspective enables engineers and plant managers to better recognize the practical advantages of the PMSM gear motor, enabling more informed decisions that go beyond theoretical performance to address these real-world challenges and objectives.

It's important to note that PMSMs are not simply direct replacements for traditional AC induction gear motors. Instead, their adoption marks a fundamental change in the way motion systems are conceived, controlled, and optimized throughout industrial operations. This distinction further illustrates the importance of a strategic approach when planning to integrate PMSM technology.



To fully leverage the advantages offered by PMSM gear motors, it is crucial for engineers and plant decision-makers to thoroughly evaluate where and how this technology delivers the greatest benefits. Equally important is understanding the scenarios where PMSM technology may not be the optimal choice. A careful assessment ensures the decisions regarding operating lines are both informed and aligned with the operational needs and long-term strategy of the facility.





Inventory Optimization and SKU Consolidation

PMSM technology introduces a powerful benefit through inventory and system simplification. Advances in the permanent magnet motor design allow a single PMSM gearmotor to cover a wider operating envelope than a comparable standard induction motor.

For equipment manufacturers and their customers, this translates directly into SKU consolidation, as fewer motor and gearbox combinations are required to support the same range of applications. Similarly, from an operational standpoint, this consolidation reduces the working capital tied up in spare parts, inventory storage, and the added complexity of parts management.

This benefit is magnified in large distribution centers or material handling installations, where dozens or sometimes even hundreds of drives may be deployed. Rather than managing a wide assortment of motor ratings, maintenance teams can standardize on fewer variables while still maintaining operational flexibility.

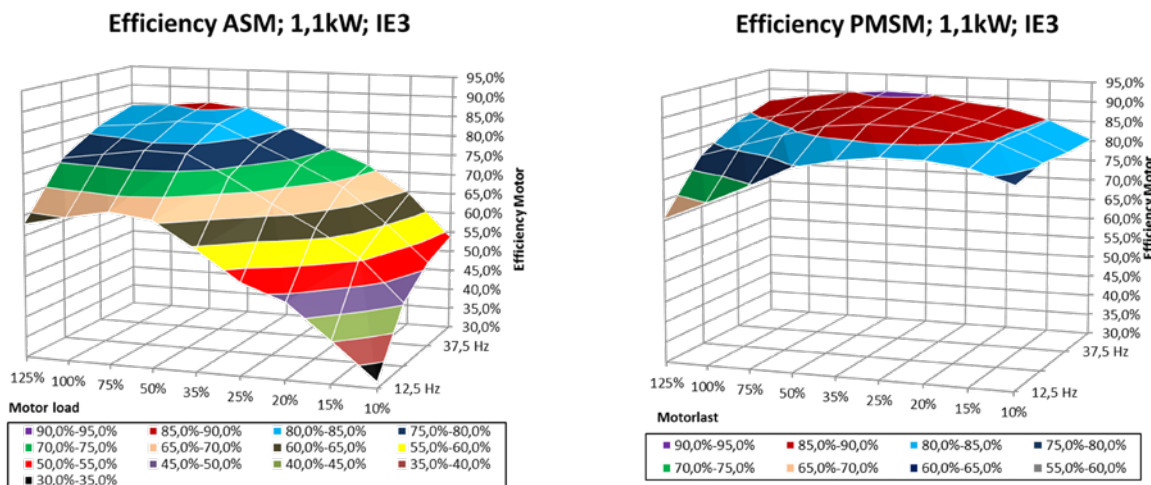
Value in Energy Efficiency for Continuous and Long-Duty Applications

One of the most cited advantages of PMSM technology over the years is energy efficiency, but the relevance of this advantage depends heavily on operating conditions. PMSM gear motors deliver their strongest performance in applications characterized by continuous operation, long duty cycles, or sustained – and especially – partial-load conditions. Conveyors, intralogistics systems, and material handling equipment that operate around-the-clock and with varying loads are typical examples of these systems.

Unlike induction motors, which rely on rotor slip to induce current and generate torque, PMSMs operate synchronously with the rotating magnetic field. Because there is no rotor losses associated with slip, overall efficiency is inherently higher. More importantly, PMSM gear motors maintain high efficiency across a broader speed and load range. This is especially critical in real-world applications where equipment rarely operates within its peak efficiency window and often runs under partial load for extended periods.

In these operating scenarios, incremental efficiency improvements compound over time. Energy savings are not realized at single operating points, but through hours and days of continuous operation – making applications with longer operating hours see shorter amortization periods when upgrading to PMSM-based systems.

PMSM Motors Maintain Efficiency Across the Expanded RPM Range



Thermal Performance and Environmental Impact

Motor efficiency and thermal behavior are a tale as old as time. Any electrical losses ultimately manifest in the form of heat, and many industrial environments face heat dissipation as a limiting factor for system reliability and performance. Because PMSM gear motors generate fewer electric losses due to their design, they naturally operate cooler than induction motors while delivering the same mechanical output.

The benefits of thermal management remain significant across a wide range of industries. Improved thermal performance also enables higher power density. PMSM gear motors can deliver more torque and power within the same envelope as induction motors or achieve the same output in smaller enclosures directly supporting compact machine designs and space-constrained installations without compromising performance.

Intralogistics and Material Handling as a Key Application Segment

Over the years of PMSM implementation, intralogistics and material handling systems have also benefitted from their use. These systems typically operate continuously, experience frequent speed changes, and benefit from precise torque control. From a system perspective, they also benefit highly from uptime and operational efficiency.

Regional market drivers also heavily influence how these benefits are perceived. In European markets, high energy costs and stricter regulatory frameworks emphasize efficiency gains dramatically. In the United States, while energy savings are an important factor, decision-makers tend to place greater emphasis on sustainability objectives, operational efficiency, and long-term flexibility.

PMSMs rated up to IE5 efficiency support widescale energy saving objectives and sustainability reporting initiatives, while also simplifying overall system architecture and inventory strategies. In these applications, the PMSM motor becomes part of a broader operational initiative, rather than a standalone component upgrade.



The Role of the Variable Frequency Drive

An unavoidable consideration that differs between PMSM gear motors and traditional induction motors is the requirement for a compatible variable frequency drive (VFD). Induction motors can operate in direct-on-line configurations, which simplifies system architecture and reduces your component count. PMSM, by contrast, requires controlled startup and operation, making the inclusion of a VFD essential for proper functionality.

Modern industrial systems increasingly rely on VFDs regardless of motor type, driven mostly by the need for speed control, energy optimization, and process flexibility. When evaluated within this context, PMSM gear motors align naturally with the trends that are already shaping industrial automation.

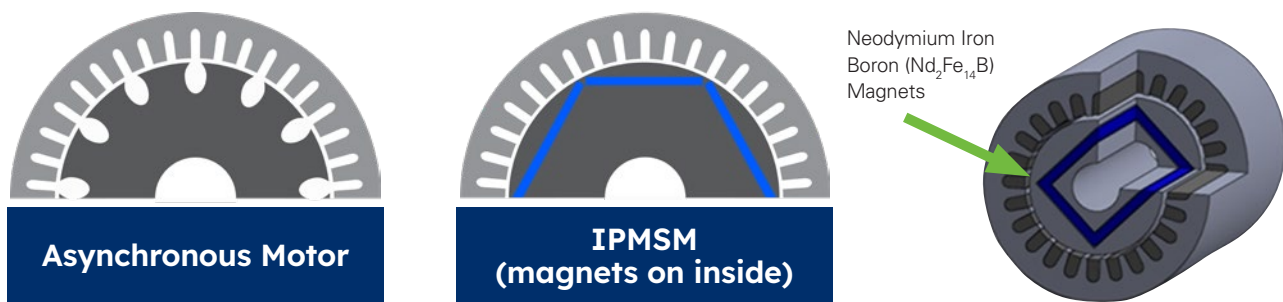
Physical Footprint and Integration

As with all new technologies and potential changes, concerns about installation space are common and justified. In practice, PMSM gear motors are generally comparable in size – or smaller – than equivalent induction motor assemblies, even with the VFD included. Additionally, higher power density allows more output to be extracted from the same frame size compared to the motor systems that may be in place already.

Compact drive units, reduced installation space requirements, and integrated designs support both retrofit and new machine builds without introducing layout complications.

Synchronous Operation and Torque Behavior Enabling System-Level Advantages

The defining characteristic of a PMSM gear motor is its synchronous operation. With permanent magnets embedded within the rotor, the motor rotates in lockstep with the stator's magnetic field. This eliminates slip, improves efficiency, and results in predictable and measurable speed behavior across its operating conditions.



From a performance standpoint, PMSM delivers high and consistent torque across a wide operating range. Full torque is typically available from considerably low speeds up to and beyond nominal operating speeds. With appropriate design and control alongside an understanding of the system needs, PMSM gear motors can safely operate at higher speeds, allowing power output to increase proportionally with speed.

This torque behavior is particularly advantageous in applications requiring frequent starts, stops, or speed changes, where induction motors may experience frequent efficiency drops or increased thermal stress.

Efficiency Across Partial Load and Variable Speed

While it is technically possible to design induction motors that meet increasingly high efficiency classifications, these ratings are often achieved with a single, ideal operating point in mind. Real-world systems rarely operate under such conditions. Equipment is commonly oversized, running at reduced loads, or experiencing variable demand throughout the day.

This is particularly where PMSM gear motors shine. Being able to maintain high efficiency across varying loads and a wide range of speeds make them the industry leader within these environments. In long-duty or variable-load systems, PMSM gear motors become a decisive factor in overall performance and delivery within your operation.

Reliability, Service Life, and Maintainability

Another consideration in regard to adding PMSM gear motor technology to your operation is the serviceability and repair factors. Despite the use of permanent magnets, PMSM gear motors are fully repairable, and there is no evidence suggesting that the magnets themselves limit the life of the motor. In fact, reduced electrical and thermal stress and more accurate power consumption can contribute to equal or improved service life when compared to traditional induction motors.

Long lubrication intervals, low-noise gearing, and robust enclosure designs further support reliability in demanding environments. While most enclosures are IP54 or IP55 rated, some enclosures – like those from Bauer Gear Motor™ for example – are rated IP65 as standard, with optional IP66 options, providing protection against dust and water spray, while corrosion protection classifications up to C5-M and C5-I enable operation in aggressive atmospheres.



Where PMSM May Not Be the Optimal Choice

While the obvious benefits of PMSMs offer clear advantages in many real-life scenarios, they are not universally the best solution. Applications characterized by very short operating times or infrequent duty cycles may still function properly with existing induction motor systems.

However, as efficiency regulations continue to evolve, the cost of adoption into PMSM technology lessens, and sustainability expectations increase, even these applications may benefit from the installation of PMSM gear motors. Proactive PMSM adoption today could be viewed not only as a general performance upgrade, but also as a strategic preparation for future requirements.



Future-Proofing Through Capability, Not Just Compliance

Energy efficiency standards in the United States currently align closer to IE3, but global trends are pointing towards increasing adoption of IE6 requirements. PMSM technology is widely regarded as the most practical and scalable pathway to achieving these future standards.

Despite individual benefits, it is important to recognize that the true value of PMSM technology lies not in chasing efficiency labels, but in the capabilities that this new technology enables. Broader operating ranges, improved controllability and monitoring, reduced thermal stress, and system-level optimization all contribute to a more resilient and adaptable design.

The Lasting Benefit of Incremental Progress

PMSMs represent a modern shift from component-level thinking to system-level optimization. When evaluated within the full context of how modern industrial equipment is built to operate – continuously, variable, and under increasing regulatory and sustainability pressures – the benefits extend well beyond efficiency alone.

For engineers, PMSMs offer a powerful tool designed for more flexible and robust systems. For plant managers, they present an opportunity to simplify operations, reduce long-term risk, and align infrastructure investments with future demands in mind. And as industrial drive technology continues to evolve, PMSMs are increasingly positioned not as an alternative, but as a foundation for the next generation of motion solutions.



About the Company

Regal Rexnord Corporation is a global leader in the engineering and manufacturing of factory automation sub-systems, industrial powertrain solutions, automation and mechanical power transmission components, electric motors and electronic controls, air moving products, and specialty electrical components and systems.

Through longstanding technology leadership and an intentional focus on producing more socially conscious and environmentally-friendly products and sub-systems, the Company is regularly addressing increasingly relevant secular demands of customers in the medical, alternative energy, aerospace, food & beverage, general industrial and warehouse/intralogistics end markets, among others. In short, Regal Rexnord's 30,000 associates around the world are proud to be working each day towards fulfilling the Company's purpose: to create a better tomorrow with sustainable solutions that power, transmit, and control motion.

Regal Rexnord is comprised of three operating segments: Industrial Powertrain Solutions, Power Efficiency Solutions, and Automation and Motion Control. Regal Rexnord is headquartered in Milwaukee, Wisconsin and has manufacturing, sales and service facilities worldwide. For more information, visit www.regalrexnord.com.

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