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Because Motion Matters™

Energy savings of up to 40 percent and more

Kollmorgen's energy efficient servo technology has made its mark with its high efficiency

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Systems driven by electric motors are responsible for two-thirds of the electricity consumed in industry. Due to constantly rising energy prices, machine designers are being asked to design new, more energy efficient machines. This is why energy efficiency is an increasingly significant consideration in the design of new machines as well as in the procurement of replacements and upgrades. One energy-saving option is to use highly efficient motors. For instance, it makes sense to replace low-efficiency asynchronous motors with high-energy class servomotors. The AKM™ servomotor is rated for energy class IE4, and is more energy efficient than asynchronous options because of it high power density, small moment of inertia, and low cogging value. Savings of 40% or more may be achieved by replacing an asynchronous motor with highly efficient servo technology consisting of asynchronous servomotor and servo drive. Depending on the machine run time and electricity prices, it is possible to save up to (1000) per axis per year in energy costs. In many applications, investment in a servo system will pay for itself within the first year.

Kollmorgen, the solution provider for drive and control technology, is committed to developing highly energy efficient drive technology. Comparative test studies demonstrate that selecting suitable motors and combining them with controllers such as the AKD™ servo drive leads to remarkable results. In addition to the inherently superior energy efficiency realized through converting to servo technology, the versatile AKD™ servo drive further reduces energy demand because of its better control characteristics. The controller contains motor data and sophisticated algorithms that generate greater precision, optimum energy demand and increased productivity. In addition, a DC bus coupling stores energy during braking that can be utilized to power other drives through the DC link. Such DC link coupling is very effective at maximizing energy efficiency in machines with multiple independently moving axes.

It is increasingly challenging to balance the need for manufacturers to build motors for a global market, while machine builders are left to decipher the various standards to determine their compatibility for the application. There are already numerous standards and regulations (NEMA, EPAct, NRCan, CEMEP, COPANT, AS/NZS, etc.), with more standards coming to help define electric motor efficiency. The newest standard, IEC 60034-30, defines energy classes IE1 to IE4 for asynchronous motors.

Asynchronous motors can reduce electrical energy usage by up to 30% by running a light load and employing a frequency inverter between the power supply and the motor. When compared with a servomotor, however, the asynchronous motor has an inherently greater demand for energy because of its design, as energy is required for the current generating the torque as well as for the magnetic field. On the other hand, synchronous motors have permanent magnets meaning they always have a counter pole. Energy consumption is used only for generating torque. Thus, energy consumption varies proportionately with speed and torque so that low speeds and torques use less current. The trend for both new designs and repairs is to give preference to servomotors - synchronous motors that are combined with a servo controller to create a servo drive. Servomotors also differ in regards to energy consumption. A number of technical measures, including copper windings in the stator that are wound extremely tight, allow AKM™ motors to achieve the same output as conventional servomotor technology, in a package that is 30 to 50% smaller.

Better energy balance thanks to a reduced mass inertia
An advantage of synchronous motors is that they have substantially lower mass inertias than asynchronous motors. Since the motor's inherent moment of inertia must be accelerated for every movement, having a lower mass inertia means reduced losses for dynamic applications. The AKM's very low moment of inertia has a lower current demand, thereby saving energy

AKM™ servomotors - taking the place of asynchronous motors
AKM™ motors are characterized by their dynamism, control quality, compactness and, in particular, their energy efficiency (IE4). The reduction in losses that result from the servomotor's low mass inertia and other factors is extremely significant in dynamic applications. The range of such applications with large acceleration components extends from machine tools, robots, pick and place systems through portals to printing presses, packaging and injection molding machinery.

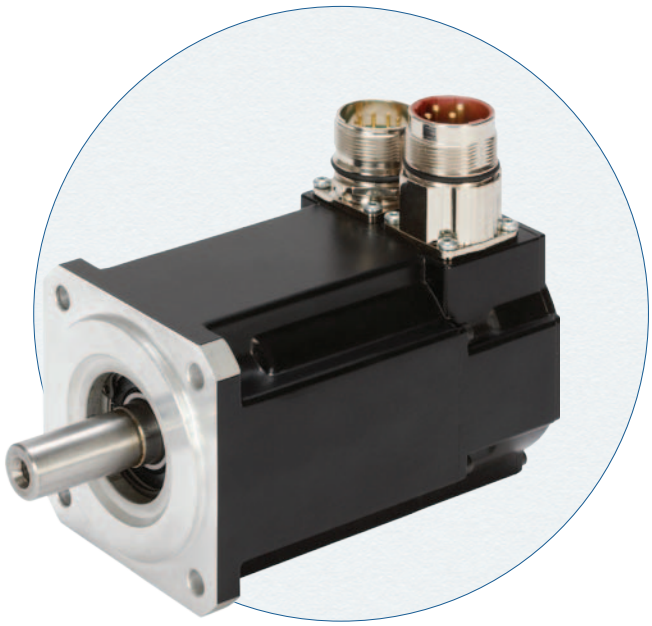
Because of the servomotor's high dynamic performance compared with asynchronous motors, replacing asynchronous motors in a typical S1 operating mode generally makes sense. With this measure, energy is provided according to the need and only to the extent that the process demands. The following example of an injection molding machine manufacturer illustrates the advantages of this procedure. In this application an asynchronous motor is used to drive an oil pump at maximum capacity in S1 operating mode. Pressure in excess of the maximum pressure required for the process is generated continuously. The process uses the pressure that is actually required, while a bypass uses the excess pressure to return oil to the oil reservoir. The pressure has to be varied four times within one injection molding process. By replacing the asynchronous motor with an AKM™ servomotor, which requires 1/5 of the energy previously consumed, the speed is reached within a few milliseconds to dynamically provide the necessary performance during the process. The AKM™ servomotor is quieter, more stable and generates less heat and eliminates the need for the bypass valve while accelerating processes. In addition, the AKM™ makes it possible to run five machines from the same feed, which previously had supplied just one machine.

Another interesting replacement occurred in a uniform pump operation; an application that is normally suitable for asynchronous motors. The manufacturer chose an AKM™ motor because of its compactness and energy efficiency as well as saving the cost of an additional fan due to its excellent heat dissipation. Plus the motor has a smooth surface, which makes it easy to clean in this challenging application.

Energy efficient design and selection of electric motor drives
Machine builders often use over-specified motors. A precise design yields optimum power output with minimal energy loss, and prevents excess energy usage in relation necessary reserves. Available in thousands of variations,

Kollmorgen's compact AKM™ synchronous servomotors - brushless three-phase AC permanent magnet motors -offer a variety of combinations that allow for maximum performance, especially in dynamic applications. Eight different sizes with many winding variants and optional feedback systems give great flexibility in machine design. The overlap of static torques and rated speeds provides a fine graduation in terms of power consumption. Adding capacitors reduces the previous demand for electric power by 30%.

On average, the mass inertia of an asynchronous motor can be 10 times higher than that of a synchronous motor. This means that just 1/10 of the energy is used in accelerating synchronous motors. The advantage of the low moment of inertia does not come into play in processes in which motion sequences in continuous operation are always in just one direction - typically pump applications. In addition to this, the fact that a slightly higher mass inertia provides for a more uniform, stable process should be taken into consideration. Although asynchronous motors have advantages in continuous speed, single direction applications, synchronous motors can reduce energy consumption up to 50% in applications with frequently changing speeds. A Kollmorgen customer in the machine tool industry demonstrated this with a multi-spindle automatic lathe that has 20 to 70 drives (Fig.: 1). This machine builder reduced power consumption by 2.24 kW, and reduced heat output by the motors from 2.7 kW to 1.3 kW



A further comparative study carried out by Kollmorgen shows that up to 1000/year can be saved in energy costs per axis, depending on machine running times and the price of electricity. A constant, uniform, single axis application used:

1. an asynchronous motor (operated fixed to the mains) without controller - energy demand: 1000 watts,
2. an asynchronous motor (IE1, Standard Efficiency) with Kollmorgen AKD™ drive - energy demand: 600 watts,
3. an asynchronous motor (IE4, Super Premium Efficiency) with Kollmorgen AKD™ drive - energy demand: 400 watts,
4. a generic synchronous servo motor (Standard) with Kollmorgen AKD™ drive - energy demand: 300 watts,
5. an AKM™ servomotor (IE4) with Kollmorgen AKD™ drive - energy demand: just 220 watts.

These comparisons clearly show the energy savings that can be realized depending on the employed technology. The AKM™ servomotor made an impressive mark with its high level of efficiency, high power density, low moment of inertia, and low cogging when compared with both asynchronous motors and conventional synchronous servomotors. This performance is enhanced by the harmonized interaction between the AKM™ motor and the AKD™ servo drive in terms of drawing energy in accordance with demand. On top of this, it was possible to save even more energy by coupling DC buses and fitting a capacity module provided by Kollmorgen, which stores the energy from the regenerative work of the axes.

Investment in pioneering servo technology not only yields significant performance improvements, but also considerably reduces energy costs. Kollmorgen's standardized servo concept features completely harmonized interfaces between the components, saves time and money during project development and commissioning, and saves energy in production.

The positive response to this servo concept has reinforced Kollmorgen's role as the leader in the industry. That's not just marketing-speak, but can be further illustrated by the following sample calculation: For a machine with 16 operating hours per day and 250 work days per year, lowering the energy demand by 780 watts corresponds to energy savings of 3,120 kWh per annum. With a machine life cycle of eight years, this corresponds to 24,960 kWh. With an electricity rate of 15 cents/kW, this amounts to reduced energy expenses of 3744 per axis.

Savings potential achieved

On the example of a multi-spindle automatic lathe with 20 to 70 drives per machine

- Reduction in JM by 59%, Jges was accordingly reduced by 43.1%
- Motor model used: AKM43 with M0 = 4.7 Nm, JM= 2.1 kgcm², cogging < 1% and THD < 1%

Per motor	Before	After	Change
Power consumed	141 W	82 W	41,8% less
Acceleration torque	9,9 Nm	6,2 Nm	37,4% less
Motor heating	79 K	39 K	40 K less
Surface finish	1,2 µm	0,6 µm	Better by a factor of 2
Maschine mit 38 Achsen			
Power consumed	5,36 kW	3,12 kW	2,24 kW less
Motor heat output	2,7 kW	1,3 kW	1,4 kW less

Saving potentials

Successive improvements reduce energy demand to an absolute minimum

Generally speaking, concentrating on one component to the exclusion of others isn't enough when considering energy efficiency; instead a holistic approach is recommended. A first step might be to replace an asynchronous motor with a servomotor to benefit from its higher moment of inertia. The use of an AKM™ will, for its part, permit higher precision and better motion profiles due to its high resolution Smart Feedback technology. Other important outcomes include more stable processes, higher machine availability, productivity, life cycle, and reduced temperature with low energy consumption. It has been demonstrated repeatedly that this better technology pays for itself in less than a year. In fact, in addition to original investment costs, it's also important to consider life cycle costs in calculating the total cost of deployment. In doing so significant energy savings can be achieved over the full life cycle of a machine.

Conclusion

With some thought and armed with the knowledge of coupling mechanisms, users can be equipped to effectively minimize EMI issues when best practices are not available.

About Kollmorgen

Kollmorgen is a leading provider of motion systems and components for machine builders around the globe, with over 70 years of motion control design and application expertise. Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.
For more informations contact us.

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