Bosch Rexroth 4EE

A SYSTEMATIC APPROACH TO ENERGY EFFICIENCY

Responding two years ago to customers' concerns about rising energy costs, Bosch Rexroth began leveraging its technologies to develop a comprehensive strategy to help customers maximize energy efficiency. The 4EE program (4 Energy Efficiency) involves four key areas including: efficient components, energy recovery, energy on demand and energy system design. (*Ed's note: See sidebar page 7*).

"Bosch Rexroth is able to take a more systematic approach to energy efficiency in customers' applications by factoring all technologies and the interplay of all components into the overall efficiency of the system," says Scott Hibbard, vice president of technology at Bosch Rexroth. "Considering the large scope of customers' industrial applications, our specific mission is to help customers reduce their overall energy usage and their impact on the environment, but also make them more profitable."

Bosch Rexroth's KST Booster.

Bosch Rexroth's IndraDrive System.

Other areas of energy efficient solutions include lubrication technologies and drive and control systems. Several manufacturing companies have recently weighed in on the overall energy savings achieved using elements of the 4EE program.

Lubrication. The Rapidstar Sup-ply Unit (RSU) system for cooling lubricants opens all of the advantages of a modular system for the low- and high-pressure supply. This new concept—on the basis of standardized assemblies—reduces energy needs and shortens the assembly times considerably. The KST booster moves the high-pressure generation into the hydraulic unit when internally cooled tools are used, and so the complete motor-pump supply line on the cooling lubricant side is omitted while the energy consumption is simultaneously reduced. The hydraulic unit that is available in the machine can be connected and deactivated, depending on the process; using an additional linear pump, it generates the necessary pressure of up to 120 bar with a flow of up to 50 l/min. Bosch Rexroth extends the service life of the supply unit by moving all open-loop and closed-loop control functions into the particle-free hydraulic circuit. Thus, about 90 percent of the applications can do without the cooling lubricant fine filter that has been necessary up to now and operating costs can be further reduced. The KST booster, that can also be retrofitted, reduces the average noise emission considerably and satisfies another important requirement of users.

"European customers using the KST booster report energy savings up to 80 percent, depending on the energy cycles," Hibbard says. "Customers also are saving money by not having to purchase coolant or the components for the motor-pump supply line."

Drive and control systems. Using a Bosch Rexroth drive and control system, MoCo Engineering and Fabricating, located in Spokane, Washington, converted an existing 10-axis hydraulic lumber stacker system into the world's first line-regenerative, electric servo-driven synchronized stickering stacker.

According to MoCo's documented tests, the company has had energy reductions from 40 to 75 percent, with savings of up to $45,000 per year. To obtain the suitable components,

MoCo teamed up with local Rexroth automation distributor Northwest Motion, a supplier to MoCo since 2000. Based on their experience with servo designs, Northwest Motion recommended a Rexroth IndraDrive drive system, IndraDyn servo motors and a common DC bus with regenerative capabilities so excess power could be diverted from one axis to another, or onto a mill's main power grid.

Multi-axis applications are the domain of the modular system IndraDrive M. Power supplies provide the necessary DC bus voltage for the inverters. Compact single-axis or double-axis inverters and power supplies with integrated mains connection components enable compact solutions for large axis groups. Maximum energy efficiency can be achieved with power supplies that are capable of mains regeneration. Besides the power recovery encountered in regenerative operation of the drives, another outstanding feature of these devices is the closed-loop DC bus.

A combination of IndraDrive C converters and modular IndraDrive M inverters is a particularly cost-effective solution for small axis groups. The converter for the first axis supplies the inverters of the other axes at the same time. In this case, a converter with sufficient power reserve must be selected that is able to supply the smaller inverters as well.

In addition, T-TEK Material Handling Inc., located in Montgomery, Alabama, developed a new high-speed beverage palletizing machine that performs faster and more efficiently than previous models—with the help from a Bosch Rexroth servo system. The new machine has a 15 to 20 percent faster cycle time—smaller motors and regenerative energy capability results in an estimated overall energy savings of 20 percent. This energy savings was achieved using Bosch Rexroth's MSK motors, IndraDrive M servo drives and HVR power supply to take the extra energy and regenerate it. The advantage is converting usable energy for the machine by powering the other servo motors on the DC voltage bus that may be in acceleration mode, instead of burning off the energy to a resistor.

An energy efficient future. By adhering to its 4EE strategy, the company has been able to provide a wide variety of solutions for its customers including energy analysis for motion control systems, gearboxes and conveyors, mounting systems for solar panels, hydrostatic regenerative braking systems and much more. "Together with its distribution partners and integrators, Bosch Rexroth is taking a stronger approach to providing complete systems and solutions to specific industry

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4EE Program

Scott Hibbard, vice president of technology at Bosch Rexroth, briefly discusses the company's 4EE Program (4 Energy Efficiency), an initiative that has been in place for two years that assists customers with a variety of green drive and control technologies.

Efficient Components: From hydraulics and pneumatics to linear motion and electric drives and controls that are optimized to reduce energy consumption with every motion, these components form the basis for energy efficient mechatronic system solutions.

Energy Recovery: Energy generated in the machine can be stored and re-used. Depending on the application and general conditions, storage-charging circuits and regenerative supply devices utilize this energy to supply it to other elements in the system, store it in a buffer for the next cycle or feed it into the electricity supply grid.

Energy on Demand: Involves using only the amount of energy that is currently needed. This idea of demand-controlled energy consumption utilizes intelligent control strategies based on the respective characteristics of the drive technologies. As a result, this combines short response times with reduced power consumption while providing at least the same high productivity. For example, variable-speed pump drives use this concept to generate demand-specific energy in hydraulic systems. They manage up to 50 percent less energy—with the same machine output. Another example is electro-pneumatic pressure control valves that can be used to control air consumption on-demand and divide the motion into different phases for this purpose. The result: up to 25 percent less air consumption.

Energy System Design: The fourth element consists of the systemic overall view from analysis via simulation, project planning and consultation, up to the optimization of process flows using intelligent controls. Essentially, Bosch Rexroth looks at how much performance and energy the system will require in later operations and then calculates the ideal combination of technologies. For more information, visit *www.boschrexroth-us.com*.

Bosch Rexroth's IndraDrive Mi (top) and Indra Control-MLL (bottom).

sectors," Hibbard says.

The company has staffed its regional center in Northern California, for example, with application engineers who are experts in semiconductor and solar applications. Product examples include the use of low friction seals in linear guide applications and the use of hydraulic technologies to make utility vehicles more efficient.

Bosch Rexroth is continuing to develop new energy efficient products in the future, according to Hibbard. "Customers who have incorporated energy-efficient drive solutions from Bosch Rexroth have been thrilled with significant energy savings and lower costs."

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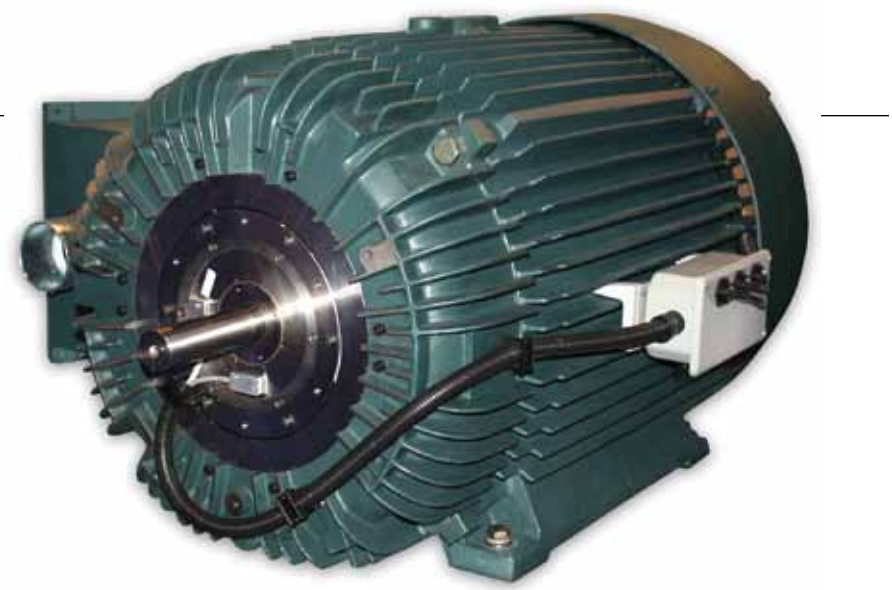
Synchrony Magnetic Bearings

HIGHER RELIABILITY, LESS MAINTENANCE



A 250 hp industrial motor supported on Fusion magnetic bearings. This motor is also fitted with a thrust bearing for those applications requiring axial force capability, such as vertical motors (courtesy of Synchrony).

Active magnetic bearings are replacing oil-lubricated bearings for new types of machines in a variety of industries. The benefits of using magnetic bearings include higher reliability with little or no maintenance, reduced frictional losses resulting in higher energy efficiency, less noise, no contaminating or flammable lubricants, reduced machine vibration and built-in machine health monitoring and diagnostics. However, despite these advantages, the application of magnetic bearings has been limited in the past by the large size of the magnetic bearings, the complexity of integrating the magnetic bearings into the machine, the need for a large external control system and the high cost. Recent advances in magnetic bearing technology, including miniaturization, simplicity and integration have overcome many of these limitations.

In a magnetic bearing system, stationary electromagnets are positioned around the rotating assembly of a machine. Typically, two radial magnetic bearings are used to support and position the shaft in the lateral (radial) directions and one thrust bearing is used to support and position the shaft along the longitudinal (axial) direction. A shaft that is completely supported by magnetic bearings is said to provide support along five axes because the bearings react to motion along the three translational axes and the two angular axes. The magnetic bearing offers little frictional resistance to motion along the rotational axis.

An active magnetic bearing consists of a stator, which contains the electromagnets and the position sensors, and the rotor, which rotates with the shaft. When the magnetic bearing is operating, each magnetic bearing rotor is ideally centered in the corresponding stator so that contact does not occur.

The position of the shaft is controlled using a closed-loop feedback system. The position sensors detect the local displacements from the shaft, and these signals are sent to a digital controller. The controller processes these signals, and calculates how to redistribute the currents in the electromagnets to restore the shaft to its centered position. Power amplifiers in the controller then readjust the currents in the electromagnets according to these calculations. This cycle is repeated approximately 15,000 times per second.

Like other kinds of bearings, the magnetic bearing provides stiffness and damping. However, unlike other bearings, the stiffness and damping vary as a function of disturbance frequency. Consequently, the stiffness and dampness can be optimized by simply changing the control algorithm.

Design innovations lead to energy efficiency. Through recent design innovations, the size of radial magnetic bearings has been reduced by more than 30 percent. The outer diameter of the stator has been reduced by splitting the flux paths and isolating the electromagnets. Using frequency-modulated sensing techniques, the size of the sensor electronics has been reduced and the signal-to-noise ratio greatly increased. Changes in design also have miniaturized or eliminated different parts of a previous bulky controller: once the size of a household refrigerator, it's been reduced to little more than the size of a DVD player. FM sensing techniques have reduced sensor electronics and eliminated the need for sensor/AD controllers; the position signal is converted using high speed digital counters. Finally, the size of the power amplifiers has been reduced through new control algorithms that make it possible to achieve stable performance of the magnetic bearing while reducing the required volt-amp rating of the amplifiers. The size reduction also means that the controller can be integrated into or mounted on the rotating machine, eliminating the need for a separate enclosure and controller.

Furthermore, it is now possible to buy magnetic bearings with the controller completely integrated into the bearing, totally eliminating the need for a separate controller. The new, compact controllers may be integrated into the casing of the machine, mounted on the exterior of the machine or integrated into the magnetic bearing. The controller may be supplied with between 48 VDC and 300 VDC of power from a power supply located far from the machine. Because the wires between the controller and the magnetic bearings are short, cabling and connectorization are greatly simplified, EMI is reduced and no special tuning of the sensors is required.

In the past, health monitoring of a rotating machine required a dedicated vibration monitoring system. However, a machine already equipped with a magnetic bearing system can also perform health monitoring without additional hardware investment. Inherent in the magnetic bearings are high resolution position sensors, digital processing and communications. Also, much of the processing of the vibration data can be performed in the magnetic bearing controller itself rather than a separate data acquisition system and processor, while only the results of these calculations are sent over high-speed Ethernet networks. Health monitoring is achieved by sampling extending the functionality with additional computer software.

Efficient design leads to lower costs. Through standardization, integration and manufacturing advances, the cost of magnetic bearings has declined. While the engineering effort to develop a new magnetic bearing system is often higher than past systems, once developed, the systems can be supplied to OEMs and end users at a much lower price than past systems. Also, the engineering effort to integrate the magnetic bearings into a machine is greatly reduced. The cost difference to use magnetic bearings

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instead of oil-lubricated bearings can be justified through the elimination of the oil lubrication system. The net result is that magnetic bearings have become much more economical to use in new and existing rotating machinery.

Through technical advances, magnetic bearings now offer advantages for a much broader range of machines and applications. For example, a 400 kW, 20,000 rpm drivetrain can be created with a high efficiency permanent magnet motor/generator. A stub shaft, extending from one end of the drivetrain, can be used for mounting a pump, compressor or turbine wheel. In other cases, it's possible to apply extremely compact radial and thrust bearings with completely integrated control electronics into a NEMA frame motor. By increasing the maximum speed of the NEMA motor, it can be directly coupled to a pump or fan without the need for a gearbox.

Design innovations related to miniaturization, integration and standardization continue to increase the general acceptance of magnetic bearings for many new and existing applications—setting the standard for better, smaller and greener.

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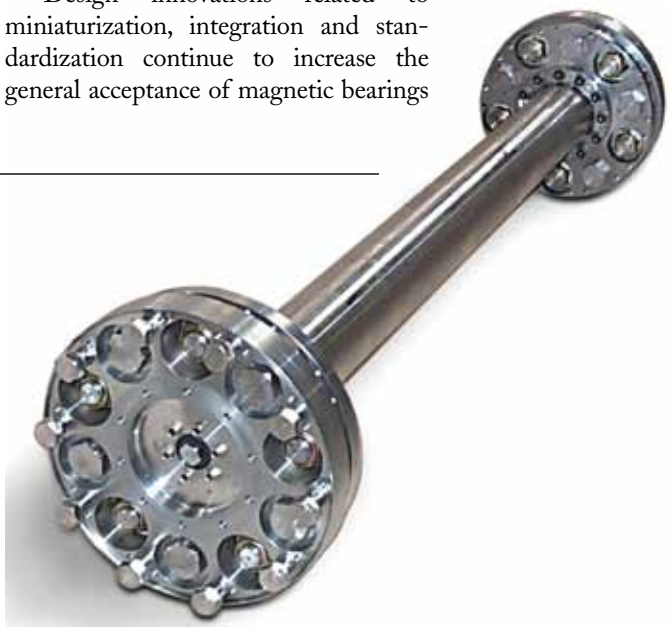

Bibby

MAKES CASE FOR MANUFACTURER REPAIR

Bibby Transmissions, a designer and manufacturer of high performance couplings for industrial, power generation and process applications, is making a case for manufacturer repair by providing possible safeguards and security for Bibby customers across the globe. "Our couplings are the most reliable of their type, but there are still occasions when they need repairing, and as the original manufacturer we think that the interests of our customers are best served by our undertaking any repairs," says Steve Broomhead, business unit manager for Bibby's Turboflex Division. "A key factor is the operating environments where they are employed. Many couplings, especially our disc types, are used in critical applications like power generation, marine, oil and gas, petro-chemical and military-where adherence to specific industry standards is mandatory. When we repair one of these couplings, the customer receives a warranted unit and the security of knowing that it conforms entirely to the original OEM standard, including final dynamic balancing and testing. However, if we don't undertake the repair, then our warranty is void—and that can have serious implications for customers in the wake of any subsequent failure."

"The second major benefit for customers of our repair service is genuine Bibby parts and materials. In some sectors of engineering industry the policy of using non-standard parts and materials in repairs is common practice, due to cost savings. However, this policy is short-sighted, because third-party repairers do not have access to the original designs and material specifications. Consequently, they have to resort to reverse engineering, which is never ideal and certainly not acceptable where the coupling is used in the sort of critical applications mentioned above," Broomhead says. "Let's not forget that some disc couplings are very high value items, and you really have to know what you are doing to repair one: the process of stripping down the coupling to look for signs of damage, removing the flexible elements, replacing them and then dynamically balancing the couplings, are all very skilled tasks which need to be undertaken by experts in the workshop—not the field. The fact that we consistently get these tasks right is one of the reasons we are ISO9001 approved and trusted by some of best known global companies for coupling supply and repair."

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Nord

OFFERS CONNECTIVITY AND TECHNOLOGY BENEFITS

Nord Drivesystems provides a technology unit for integrating motor-mounted SK 200E inverters into EtherCAT networks and the Beckhoff control technology environment. The Ethernet-based fieldbus offers benefits particularly for distributed networks such as conveyor systems. The new EtherCAT module from Nord connects a large number of inverters to a single bus line, since there is no need for repeaters or additional bus master interfaces.

The bus module can be mounted either directly on the SK 200E's interface unit or separately from the inverter by means of an optional wall mounting kit. The EtherCAT bus line is connected to the box via an M12 plug connector. Additionally, the module features eight integrated 24V inputs and two 24V outputs. A single technology unit can address up to four inverters via EtherCAT. An integrated RS232/RS485 interface allows for on-the-spot access to the parameters of the bus module and connected inverters by means of the SK PAR manual control unit or via Nordcon PC software. The EtherCAT technology unit has a standard protection rating of IP55, and can be supplied for IP66 on request.

All SK 200E inverter models provide sensorless current vector control, a brake chopper and a control module for an electromagnetic brake. Even the basic model allows for speed control (incremental encoder input HTL signal) and positioning control by means of the integrated Posicon function. The extended range of features includes the integrated safety function "Safe Stop" and an onboard interface for the AS-Interface bus system.

For more information:

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Custom Collar and Couplings

BOAST SPECIAL-PURPOSE DESIGNS

Standard and custom collars and couplings offered in a wide range of designs for building and maintaining conveyor drive systems and frame structures are available from Stafford Manufacturing Corp. Stafford Conveyor System Components feature a wide range of shaft collars and couplings that are supplied in many special-purpose designs to assist machinery builders. Included are hex and square bore collars for positive drive applications, flange collars for mounting equipment, rigid couplings for connecting motors and shafts, threaded bore collars for adjustability, mounting collars for sensors and cameras and standard round bore collars. Suitable for use in a variety of application environments, Stafford Conveyor System Components are available machined from materials such as steel, stainless steels, aluminum, brass, bronze, Delrin, nylon and high temperature alloys. Sizes can range from 1/4" to 16" I.D. and machining tolerances to 0.0005" can be achieved, depending upon material and configuration.

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Motor

SUITABLE FOR EXTREME OPERATING CONDITIONS

Maxon recently launched its EC22 HD (heavy duty) motor, a 22 mm-diameter brushless motor developed for the exceptionally high requirements in deep drilling technology and capable of resisting the most extreme operating conditions. The electronically commutated EC22 HD motor was developed in collaboration with the oil exploration industry and is designed to operate at depths of around 16,000 feet and in boreholes up to 36,000 feet long.

As part of the motor's development program, a high-temperature test facility was built, and extensive field trials were undertaken. The motor operated at temperatures up to 240 degrees C and under atmospheric pressure conditions from high vacuum to 25,000 psi. It has also been proven to resist impulse and impact forces of 100 G. It can operate while submerged in oil, trebling its 80 W output rating to 240 W because of the improved heat dissipation. Although developed to perform critical downhole actuation functions, Maxon believes the new motor will also appeal to other industries where reliability is essential. The motor's efficiency of 88 percent in air (and above 70 percent in oil) makes it particularly suitable for battery-powered applications.

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