Energy efficiency in automation

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In 2007, B&R supplied over 65,000 servo drives to customers from the machine and equipment manufacturing industry. And this trend is increasing rapidly. A cornerstone for this success: Drive technology with an integrated solution for saving energy. Who will benefit from the solution, and who should continue to get their power "from the socket"? An efficiency analysis can provide some answers.

If someone speaks about energy efficiency, they are referring to reduced costs. Today, the changing requirements of cost-conscious machine manufacturers are a major driving force for modern drive concepts. To guarantee a comprehensive approach in the design phase, it makes sense to use specifically defined rules:

- Efficiency is not possible without a specified concept
- Using powerful motion software
- Avoiding oversizing
- Avoiding the loss of energy
- Coupling drive energy and taking advantage of brake energy
- Analyzing and optimizing the application
- Relying on expert partners

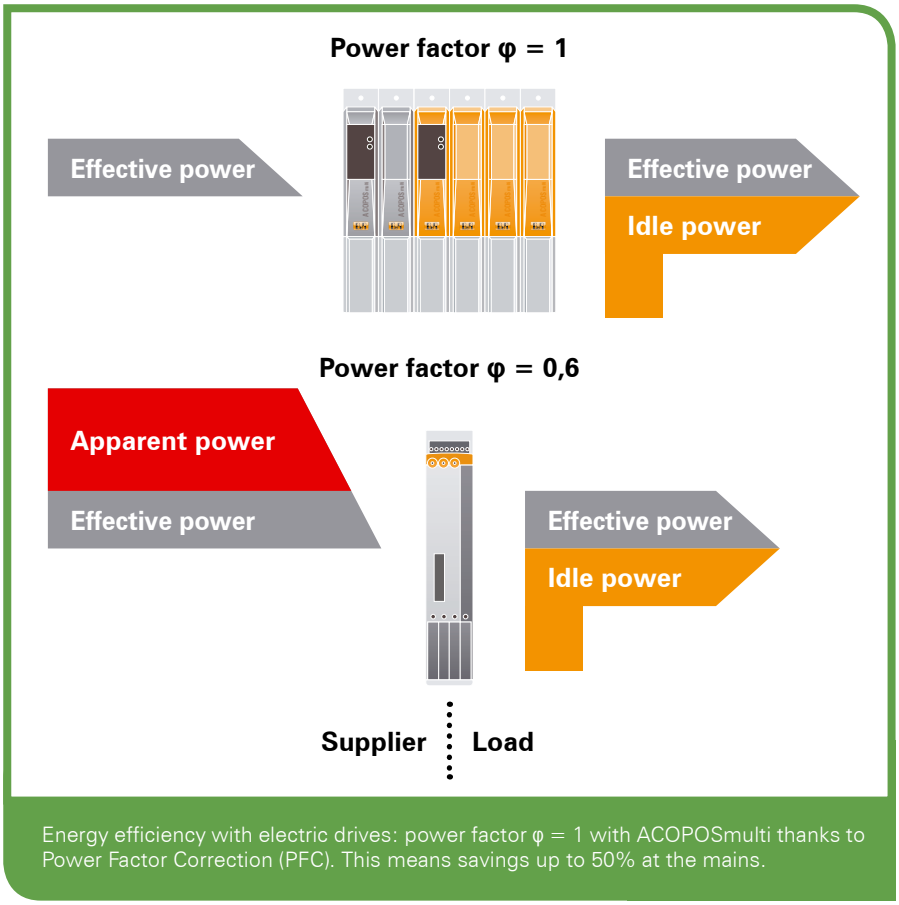
Efficiency is not possible without a specified concept

If a large number of people make the same error, many also have the same problem. So let's take a look at the most important issue before discussing drive dimensioning, efficiency or regenerated brake energy: Is the right automation concept being implemented?

Efficient automation concepts are based on multifunctional components without performance limitations

caused by processors, memory or communication technology. Deterministic multitasking, negligible reaction times as well as a complete software concept are cornerstones of energy-saving drive concepts.

Therefore, the primary goal must be eliminating separate drive controllers, separate CNC controllers, separate robotics controllers, separate control systems, separate software tools and non-uniform field bus systems. Uniform B&R automation concepts are based on components that meet all demands regarding modularity, topologies and performance. Powerful and multitalented devices can be used in a local or remote structure according to requirements. The necessary components for drive control can be distributed throughout the automation system as desired. Ethernet POWERLINK provides the basis for precise synchronization in the µsec range. All motor and motion parameters are available to all communication participants in real-time.



Energy efficiency with electric drives: power factor φ = 1 with ACOPOSmulti thanks to Power Factor Correction (PFC). This means savings up to 50% at the mains.

Conclusion:
Without a modern automation concept, sufficient energy efficiency cannot be obtained. Eliminating unneeded components can save a lot of money - not to mention the additional energy savings.

Using powerful motion software

Creating an efficient drive setup for a single axis is usually not a problem - but this becomes much more difficult for a group of axes. Most branch-specific procedures are not limited to one drive unit; instead, they are very often the product of coupled axis movements. In this case, powerful motion software with comprehensive technology functions is the basis for energy efficiency.

Here, software is needed that permits energy-optimized movement guidance in the axis group and provides branch-specific axis technology functions. B&R has thought this approach through to the end: The concept of Generic Motion Control combines the worlds of robotics, CNC, linked axis movements and single axis positioning in one homogenous system. The advantage for B&R customers: Energy efficiency through the use of technological synergy effects, for example through the integration of individual productions procedures.

Conclusion:
Software shapes a modern automation system - targeted use provides support for modernization, especially in regard to energy-efficient drive setups.

Avoiding oversizing

Oversizing drives is the main source of inefficiency and there is an enormous potential to save acquisition and energy costs here. Research that was done for new B&R customers shows that approximately 20% of the drive components used up to then were oversized. In reality, these oversized motors are operating considerably below their rated output. The result: Efficiency sinks, and energy costs rise - costs that must be paid by the system operator and not by the machine supplier.

B&R works to provide all of its customers with optimally sized drives. A defined requirement profile is essential for this sizing: The most important data includes precise analysis of the dynamics, speed and performance requirements, the movement profiles, the mechanical coupling and the environmental conditions as well as extensive information about the thermal conditions. Available planning tools include the software package ServoSoft. ServoSoft combines the setup of electrical and mechanical drive components, and is a tool for scaling and modeling entire B&R servo systems.

Conclusion:
Simple yet accurate drive sizing can be done without problems. Avoiding oversizing not only helps to lower acquisition costs for drive units, it also reduces energy costs.

Avoiding energy loss

Drive efficiency has constantly improved over the course of time. However, the loss of energy and the generation of heat associated with it are still important issues. Energy loss can be easily avoided if the following rules are followed:

- Active power supply: Only the energy actually required is put to use
- Power regeneration unit: Brake energy must be prevented from conversion to heat
- Cooling technology: Heat dissipation must be minimized
- Motor technology: More efficient motors are used

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Active power supply

How do you make sure that energy is used efficiently? Active power supply modules with power factor correction ensure purely sinusoidal current consumption from the mains. This is a measure that is also used with non-sinusoidal values and thus reduces the effective value of the current to a minimum. There is an optimal relationship between effective power and apparent power here (almost ‚1').

While conventional inverters with a small power factor clearly have higher effective power consumption, the active power supply on the B&R ACOPOSmulti ensures efficient use of energy. Cost considerations: Actually, all system installations have compensation measures to reduce the apparent power. If an inverter is placed between the motor and the power mains, the operator only pays for the effective power. Active power factor correction does not directly reduce electricity costs. However, there are enormous indirect cost advantages: Through the regeneration capabilities of active modules, through thermal optimization and through the reduction of oversizing all motors, drives, safeguards, connection cross sections and transformers.

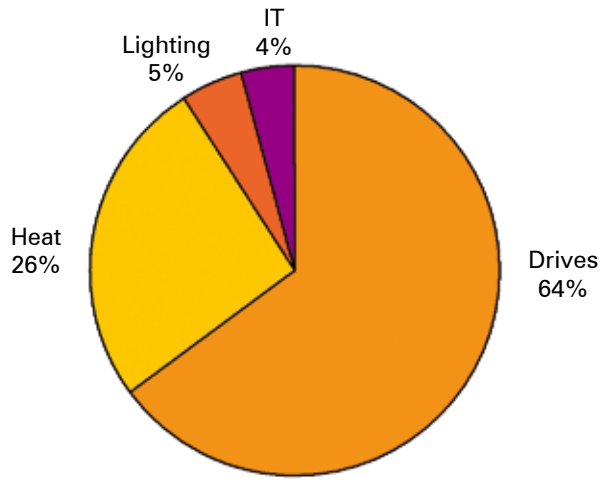
Power regeneration

All of the ACOPOSmulti power supply modules are capable of power regeneration, which prevents kinetic braking energy from being converted into heat. Unlike conventional devices, there is absolutely no heat generation caused by braking resistances. The integrated power regeneration system provides an efficient and environmentally-friendly method for preventing braking energy from resulting in heat build-up in the switching cabinet.

Using the cold plate cooling method, the dissipated heat is transferred out of the switching cabinet using water or oil, and is ideally fed back into the existing cooling circuit.

Cooling technology

Even with the most modern drive technologies, thermal dimensioning of switching cabinets remains a topic: The use of fans and climate control units in switching cabinets and production halls results in significantly higher energy costs and additional maintenance expenses. This is somewhat alleviated through the use of the cold plate cooling method. This method transfers dissipated heat out of the switching cabinet using water or oil, and is ideally fed back into the existing cooling circuit. This relieves production halls of heat dissipation resulting from the drives. This arrangement is far more effective than conventional cooling units, and therefore more energy efficient.



This diagram shows the industrial power consumption in Germany in 2002. The potential savings for drive technology are apparent. (source: ZVEI)

Motor technology

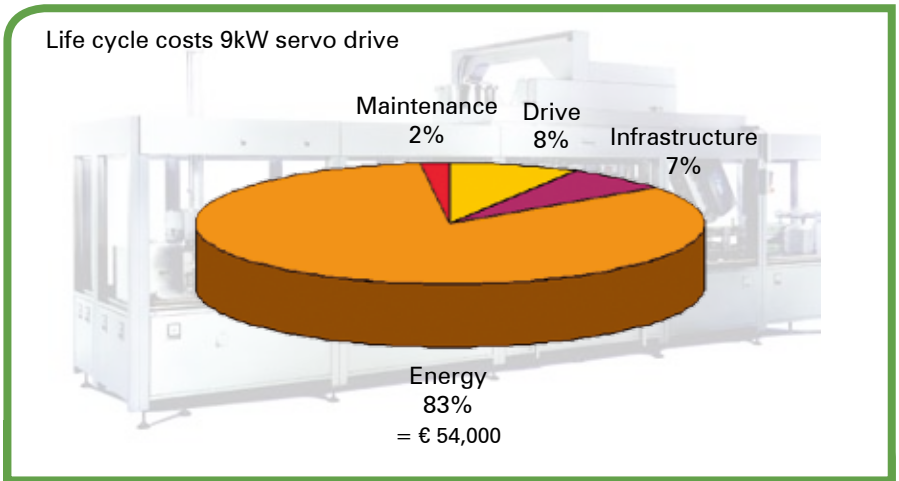
Modern production machines demand compact, dynamic motors with a low moment of inertia and optimal efficiency. Synchronous servo motors are the ideal solution here and are clearly more energy efficient compared with induction motors because the fields are established using permanent magnets. The result: Lower apparent power, improved efficiency, less heat loss and therefore increased energy efficiency.

Coupling drive energy and taking advantage of brake energy

If you brake, you win: The actual increase in efficiency of active power supply modules comes from the ability to feed the energy generated by braking back into the mains power supply. Two fundamental conditions apply here:

a) Does the machine use the brake?

This question sounds trivial, but a motor that runs continually in s1 operation does not offer the possibility to use the



Example for life cycle costs: transport servo drive with 9 kW for a yoghurt filling machine. Potential savings of 27.900 € (43 % TLC) through active power regeneration, cold plate mounting, power factor φ=1. (calculations: B&R)

brake energy. In this case, an active power supply unit does not save costs compared to a passive power supply - the energy costs are identical, and the initial drive unit acquisition costs are the only relevant factors here.

If the machine components run in start/stop operation (the drive axes accelerate and then brake), you save money with a regeneration unit. With regeneration of 25% of the energy, the additional price of an active power supply as compared to a passive unit already pays off after one and a half years. And the savings continues - up to 25% of the costs, depending on the amount of energy that is regenerated. Another advantage: The brake energy is not converted to heat energy when using regeneration.

b) How high are the power supply losses?
Brake energy regeneration must be higher than all power supply losses in the drive system, otherwise no energy is saved. The ACOPOSmulti system also has a trend-setting power supply design. The energy loss from the filters, the choke, the power supply module and the 24 V auxiliary supply module were reduced to a minimum and therefore offer the best conditions for improving efficiency using regeneration.

Analyzing and optimizing the application

How many machine manufacturers invest the time and effort to examine drive units for oversizing after prototypes are created? How many system operators take advantage of the possibilities for analyzing effective and apparent power or the quality of the power mains? Here, the amount of time and effort that has to be invested in order obtain the necessary analysis data is decisive. Conclusion: No time and no effort - with the right software tool.

In B&R Automation Studio, all current and historical power data for the drive axes is available for diagnosis on the higher-level control unit - an ideal situation for optimizing drives and maximizing efficiency. Power Meter, which is integrated in Automation Studio, is a comprehensive tool for power mains analysis. It provides high-quality measurement of effective, reactive and apparent power.

Relying on expert partners

Machine suppliers usually install machines for customers that are low-cost and that meet the requirements at hand. However, if the ongoing energy costs begin to exceed the initial costs of the machine as early as three years after purchase, the life cycle costs become a disadvantage to the customer. Additionally, it can be extremely unfavorable if system operators specify that machine manufacturers must use certain subcontractors: If inefficient drive products and concepts are provided by subcontractors, the machine manufacturer does not really have the option to select another supplier.

Conclusion:

Machine suppliers that prove to be experts in energy efficiency are always also a good partner for any subsequent business. For example, an active power supply unit can be easily sold to an end customer if the added value after two years of production is made clear.

It's important to rely on drive solution suppliers that advise their customers to size equipment optimally and that bring about energy efficiency through innovative products and automation solutions. B&R sales and application engineers provide optimized setups and competent engineering for drive technology. B&R customer consultants provide system operators and production companies full consultation regarding energy efficiency.

The author:

Ralf Henkel has been employed at B&R Germany in Bad Homburg since January 1st, 2000. From 2000 to 2006, he was an applications engineer for projects such as packaging machines, extrusion machines and printing facilities.

As of 2006, he has been working in technical sales.