European efficiency classification scheme for low voltage AC motors

TM03 Rev C 2006

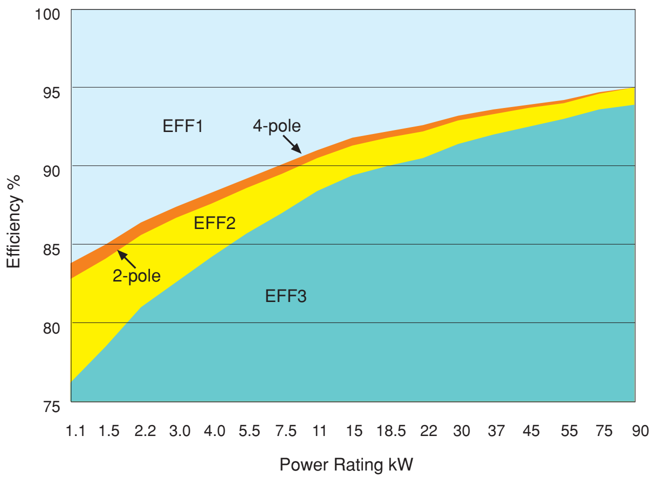
Technical notes

Businesses and other organizations are increasingly focusing on ways to minimize their energy usage. One way in which they can achieve significant energy savings is by using high efficiency electric motors.

End users should specify high efficiency motors to machines suppliers and OEMs. The European efficiency classification scheme is a useful tool for identifying efficient motors.

How does the scheme work?

The scheme divides motors into three efficiency levels, EFF1 - EFF3, with EFF1 being the highest efficiency level. It applies to two- and four-pole, three-phase squirrel cage induction motors, rated for 400 V, 50 Hz, S1 duty class, ranging from 1.1 to 90 kW output. This covers the vast majority of electric motors on the European market. Full details of the scheme can be found at www.cemep.org.



How much money can efficient motors save?

The electric motor is still the workhorse of industry, and motors account for some 65% of electric consumption in industry. Over its life a motor can cost 100 times more to run than it did to buy. This provides significant scope for energy saving.

Other incentives:
In addition to energy savings, some countries also provide financial incentives for the use of energy efficient equipment. The UK, for example, has a scheme which provides important tax and other incentives, see www.eca.gov.uk.

Single motor:
In a situation where a 15 kW motor operates for 6000 hours per year driving a water pump, an EFF1 motor can provide an energy saving of 4 MWh each year when compared with an EFF3 motor. (Assumes 4-pole motor operating at full load, efficiency levels of 91.8% for EFF1 and 88.2% for EFF3 motor. Source: CEMEP brochure).

Complete plant:
A typical medium-sized plant with 149 motors rated between 0.37 and 132 kW could save around 3.4% of the annual cost of electricity for its motors by upgrading to EFF1 motors. Even greater savings are possible when energy efficient motors are used in conjunction with variable speed drives.

No. of motors	Rating (kW)	kW consumed	Total kWh p.a.	Energy cost (EUR)
108	0.37 - 7.5	238	1,428,000	121,380
34	11 - 45	663	3,978,000	338,130
7	55 - 132	414	2,484,000	211,140
			Total:	**670,650**

Saving achieved when upgrading from EFF2 & EFF3 to EFF1 motors:
Conditions - 6000 hours p.a. - 0.085 EUR/kWh
Average efficiency improvement 3.14%
Saving 44.2 kW or 22,542 EUR per annum in energy (i.e. 3.4% of energy bill)

ABB has a full range of motors in EFF1 - the highest efficiency level - and no motors in the lowest class, EFF3.
All ABB motors are optimized for use with VSDs, and ABB is also a leading manufacturer of drives.

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What other benefits do efficient motors provide?

In addition to energy savings, high efficiency motors provide other major benefits. The use of superior materials makes for cooler operation, which means a longer lifetime and higher reliability with less maintenance. Cooler operation also means that the motors can be fitted with smaller fans, resulting in lower noise levels.

By reducing their energy consumption and costs, businesses can boost their competitiveness. At the same time they are also contributing to efforts to protect the environment by helping to reduce overall CO_2 emissions. It has been calculated that if high efficiency motors (and VSDs) were used throughout Europe, energy savings equivalent to the output of several large power stations could be realized, with a dramatic reduction in CO_2 emissions.

How can I tell if a motor is energy efficient?

A motor's EFF classification is shown on its rating plate. More detailed information is available from product catalogues, where manufacturers show the efficiency of their motors expressed as a percentage at full and ¾ load.

The European Commission has also created the EuroDEEM database which includes information on the efficiency of motors available on the European market. This database can be accessed on the Internet at http://energyefficiency.jrc.cec.eu.int/eurodeem/index.htm.

What factors contribute to motor efficiency?

Efficiency is a measure of how well a motor converts electrical energy to useful work. Energy lost in the process is emitted from the motor as heat.

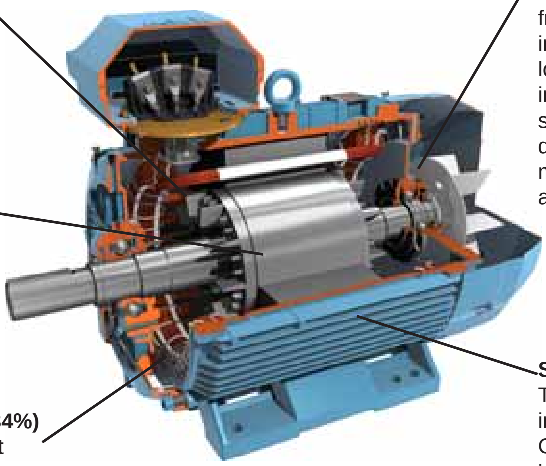
Losses can be divided into five major areas, all of which are influenced by design and construction decisions. One design consideration is the size of the air gap between the rotor and stator. Large air gaps minimize manufacturing costs. In general, smaller air gaps improve efficiency and power factor. Even smaller air gaps further improve power factor, but reduce efficiency and risk vibration problems.

Motor losses fall into two categories: no load losses, which are fixed and remain constant, and load losses, which increase with motor load. The illustration below shows the distribution of losses in an M3BP motor.

Iron loss in core (18%)
Energy required to overcome opposition to changing magnetic fields in the core material. Can be decreased by using better quality steel and by lengthening the core to reduce magnetic flux density.

Rotor losses (24%)
Heating in the rotor winding. Can be reduced by increasing the size of the conductive bars and end rings to produce a lower resistance.

Stator copper loss / I^2R loss (34%)
Caused by heating due to current flow through the resistance of the stator winding. Can be reduced by modifying the stator slot design or by decreasing insulation thickness to increase the volume of wire in the stator.



Windage and friction loss (10%)
Air resistance and bearing friction are essentially independent of motor load. Can be reduced by improved bearing and seal selection, air flow and fan design. Energy efficient motors produce less heat and can use a smaller fan.

Stray load losses (14%)
The result of leakage fluxes induced by load currents. Can be improved by improving slot geometry.

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