Best Practice High Efficiency Motors

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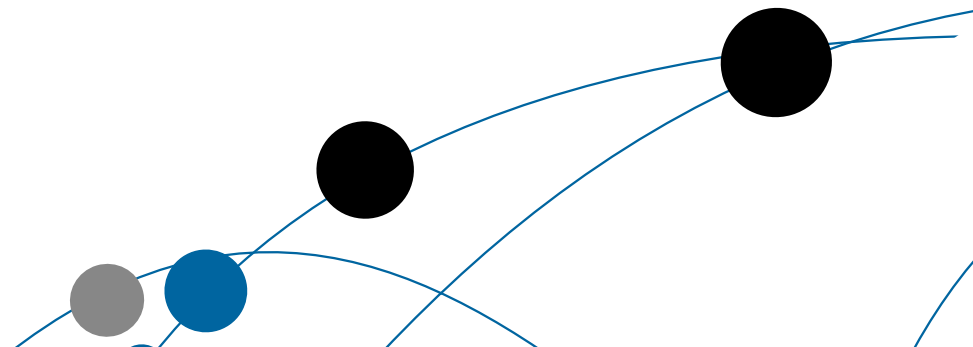
Contents

Introduction

Installing high efficiency motors can save energy and reduce operating costs. European legislation (EU Directive 640/2009) also makes the use of high efficiency motors mandatory.

For Atex environments special motors and Frequency controls are becoming more available.

Source: AkzoNobel



Recommendations

1. Use the correct size motor. The efficiency of the motors is better when running above 60% of their rated capacity and higher. The efficiency drops when running below 50% capacity.
2. Survey your motors. Gather nameplate information and obtain field measurements (voltage, amperage, power factor, operating speed) under typical operating conditions. Also identify age, efficiency, quality and use of the motor. Initially focus on motors that exceed minimum size (1 kW) and operating duration criteria (6000 hrs.)
3. Divide your motors into the following three categories:
   - Replace Immediately — Motors Offering Rapid Payback through Energy Savings. These include motors that run continuously (typically 8000 or more hours a year) and are currently inefficient (including oversized motors).
   - Replace at Time of Failure — Motors with Intermediate Payback. When these motors fail, you will want to replace them with an energy-efficient model.
   - Leave Present Situation as is — Motors with Extended Payback. These motors are already reasonably efficient or are used less than 2000 hours each year. They can be rewound or replaced with a similar motor.
4. Distinguish between long and short running time periods

Motor driven systems

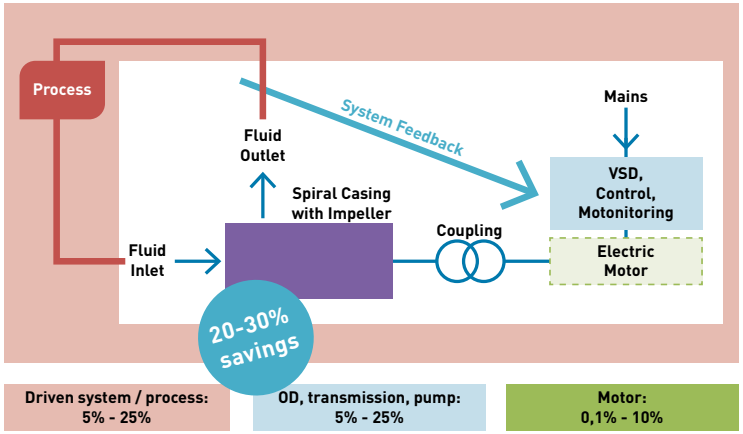
Pumps are part of a motor driven system, comprising the pump, the motor, the coupling between them and the capacity control system.

When looking for an optimum in performance and energy efficiency one should always look at the total system for the best cost effective solution.

Savings in the order of 20-30 % on the energy efficiency are possible.

The Best Practices for individual parts (high efficiency motors, capacity control and variable speed drives) are given in separate documents

Source: Spice3 workshop SBE September 2014 presentation efficient motor drives.



Importance of improving motor efficiency

Improving the efficiency of electric motors and the equipment they drive can save energy, reduce operating costs, and improve the company's productivity by minimizing unscheduled downtime which also represents savings.

Because they are constructed with improved manufacturing techniques and superior materials, energy-efficient motors usually have higher service factors, longer insulation and bearing lives, lower waste heat output, and less vibration, all of which increase reliability.

Improved design, materials, and manufacturing techniques enable energy-efficient motors to accomplish more work per unit of electricity consumed.
Besides, according to the European Commission, the new motor efficiency scheme will be based on the efficiency classes defined in the IEC 60034-30 standards published by the International Electro technical Commission. These range from the low efficiency IE1 category up to the super-premium efficiency IE4 category.

The first phase of the scheme is due to come into effect on 16 June 2011. This will require all single - speed, three-phase squirrel-cage induction motors with output ratings from 0.75 to 375kW will have to achieve at least the IE2 efficiency level. The scheme applies to motors with two, four or six poles. The second phase will begin on 1 January 2015 and will require motors rated from 7.5 to 375kW to achieve the higher IE3 efficiency level or meet the IE2 level and be equipped with a variable speed drive (VSD).

Finally, the same regulations will be extended to apply to motors as small as 750W in 2017.
There are no plans to make IE4 motors mandatory because there are currently no defined efficiency values for this class. The class will cover 'super-premium' technologies such as permanent magnet motors.

When should you consider buying an energy-efficient motor?

Energy-efficient motors should be considered in the following circumstances:

- For all new installations
- When purchasing equipment such as
- compressors, HVAC systems, and pumps
- When major modifications are made to facilities or processes
- Instead of rewinding older, standard efficiency units
- To replace oversized motors
- As part of a preventive maintenance or energy conservation program.

Financial Savings and Pay-out-time for electric motors

Many business owners hesitate to replace old motors because the capital cost of a new motor usually exceeds the cost of repairing the old one. This is a valid concern, but it is important to recognize that motors themselves may be quite inexpensive compared with the cost of power they consume.

To illustrate this point it is assumed to have a serviceable standard-efficiency motor, Pm =15 kW, 1500 rpm, 400/690 V, general-purpose motor, one that might have been produced several years ago.

It is assumed the motor operates 8000 hours per year at 75 % of full load, and that power costs is 0.08 €/kWh1 (typical business power cost). This motor has an average efficiency rating of 84 % at full load.

Using the operating parameters and power cost given above, the motor will consume 107 MWh of energy annually, and the annual cost of operating this motor will be € 8,500.
Now comparing that motor with one with better efficiency requirements (High Efficiency motor EFF1), operating continuously for 8000 h/y at 75 % load, and at 90 % efficiency (efficiency usually peaks near 75 % of full load), the annual cost to operate the motor would be € 8,000.
This is EUR 500,-- less per year than the standard-efficiency model it replaces. The amount of savings depends mainly on the hours the motor is running, the load factor and the efficiency of the old and new motor.

If, on the other hand the motor is upgraded to a Premium efficiency motor that has an efficiency of 92.1 % at 75 % of full load, the annual cost to operate this motor over the standard model will be € 7,800. This is EUR 700,-- less per year than the standard-efficiency model it replaces. Such new Premium Efficiency motor would pay back its purchase price in 2 year.

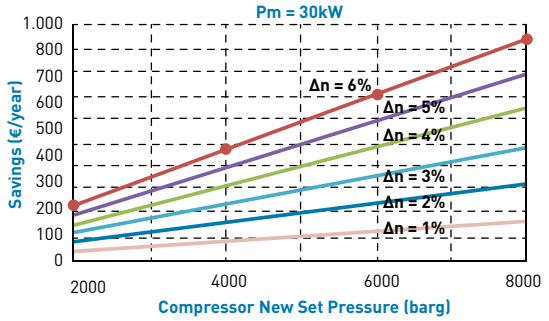
See **table 1** for comparisons on savings of the different motors.

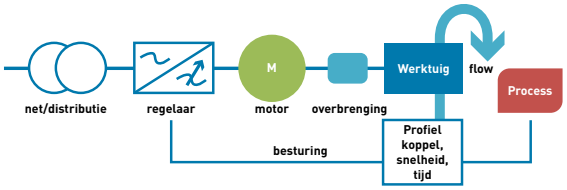
The financial savings in Figure 1 are visualized for 4 different motor powers Pm (30 kW, 55 kW, 75 kW, 110 kW) considering the energy cost of 0.08 € /kWh. The financial savings are plotted as a function of the running hours per year T [h/year].
The Pay-out-time tP.O.T. in Figure 2 is plotted as a function of the running hours a year. Note that the tP.O.T. with the increase of the efficiency (€) of the motor.

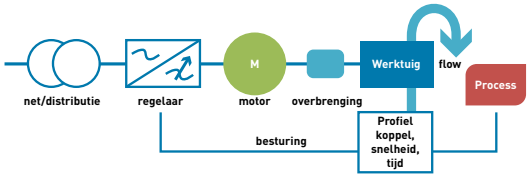
Tabel 1: Comparisons on savings of the different motors

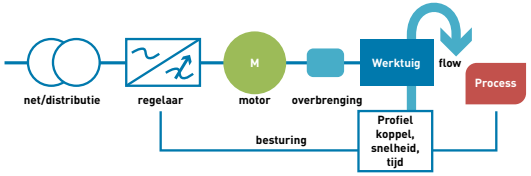
Table 1	Efficiency	Energy Cost (€)	Motor Cost (€)	Savings (€/y)	Pay back time (y)
Low Efficiency (installed motor)	84%	8.500	Cost of Repair + extra cost for poor efficiency		
High Efficiency	90%	8.000	1300*	500	2.6
Premium Efficiency motor	92,1	7.800	1500*	700	2.1

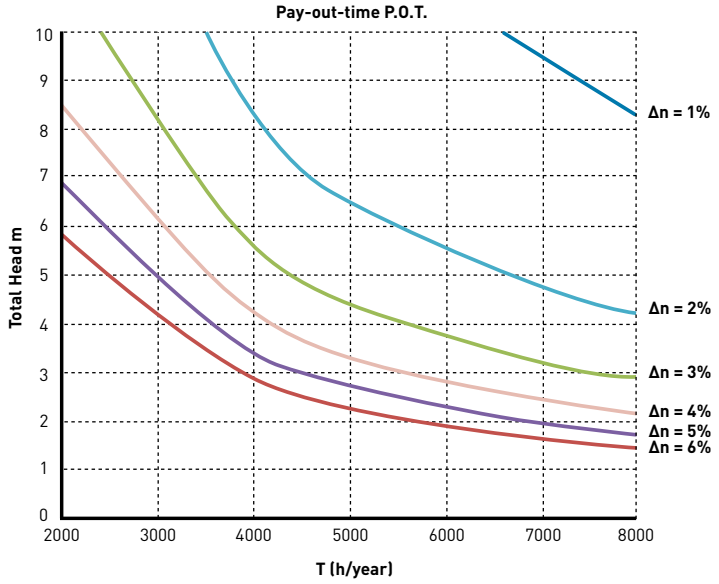
* *Price for the Netherlands 2009 ABB*











A first indication of possible actions can be obtained by the following quick check:
Every motor is scored on age, power and hours following this scheme

Age (years)	< 5	< 10	<15	< 20	> 20
Power rating (kW nom.)	> 1500	< 1500	< 500	< 150	< 50
Running hours (hrs.year)	< 2000	< 3000	< 4000	< 5000	> 5000
Points	1	2	3	4	5

Decisive is the some of the three scores (age, power, running time)

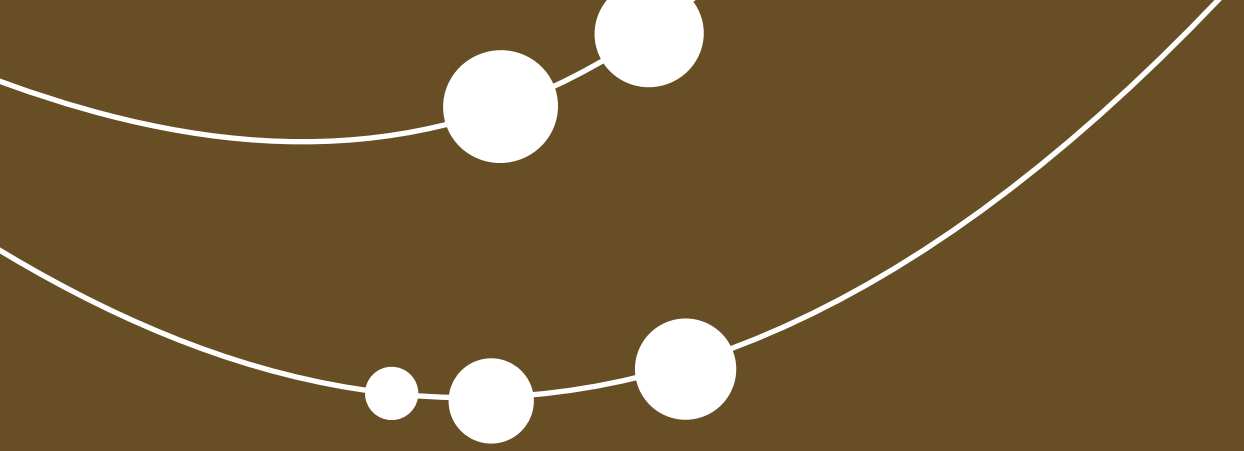
score > 10 points	replace motor
score from 6 to 10 points	to be studied in more detail
score below 5 points	leave motor in place

e.g. a motor with :

- age between 5 and 10 years: scores 2 points
- power rating between 150 and 500 kW scores 4 points
- running hours between 2000 and 3000 hours : scores 2 points

total score is 8 points, which means further evaluation is needed

(source : Spice3 workshop VNCI/SBE September 2014, presentation on Motor drives)



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Source: AkzoNobel