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Energy Savings and Improvement Opportunities by Energy Efficient Motors in India

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Abstract: In the future, the cost of energy will increase due to environmental problem and limited sources. The electric motors consume a significant amount of electricity in the industrial and in the tertiary sector of the India. Because of its simplicity and robustness the three phase squirrel cage induction motor is the prime mover of the modern industry. The electric motor manufacturers are seeking methods for improving the motor efficiencies, which resulted in a new generation of electric motors that are known as energy efficient motors. This paper deals with energy conservation by installing energy efficient motor (EEM) instead of standard efficiency motor. and One case study. This transition becomes a necessity as a direct result of limitation in energy sources and escalating energy prices. In the end of this analysis there are different practical cases in where EEM is compared with standard motor and rewound motor, In all these cases energy savings can be achieved and the simple payback is less of five years. The energy consumption of electric motors is broken into two categories. Direct energy consumption which is the energy consumed while performing work and indirect consumption the fixed energy consumed regardless of the operational state. So, it is very interesting the implementation of EEM in the industry.

Keywords: EEM, Standard efficient motor, Improvement Opportunities, Energy Saving.

I. INTRODUCTION

In the future, the cost of energy will increase due to environmental problems and limited resources. The electrical energy in the industry. The induction motor is the main driven system in the modern industrial society. Implementing energy efficient motor could save India a significant amount of electricity.

It would also reduce the production of greenhouse gases and push down the total environmental cost of electricity generation. Also these motor can reduced maintenance costs and improve operation in industry. India has a great dependence on energy; therefore it is an important goal the promotion of energy efficient motors to be applied in the industry.

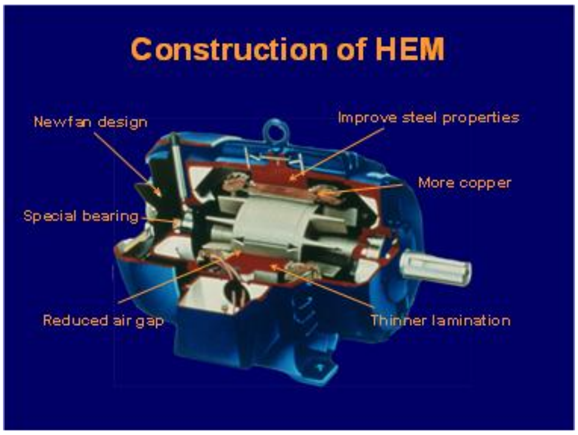
This opportunity of high energy efficiency potentials has also been recognized by policymakers, who have aimed at overcoming the barriers since the 1990s.

Consequently, policies like minimum standards and motor labelling schemes were introduced in many countries of the world.

Energy audit schemes and capacity development programmes that focus on system optimization were established as well.

II. ENERGYEFFICIENTMOTOR (EEM)

A .DEFINITATION:-
An EEM produced the same shaft output power, but uses less input power than a standard efficiency motor.fig 1.1



Standard motor is a compromise between efficiency, endurance, starting torque, and initial cost (with strong emphasis on the initial cost). Standard motor generally competes on price, not efficiency on the contrary. EEM competes on efficiency. not price.

There are a lot of terms in order to name this kind of motors. For example "energy efficient", "energy premium" or "energy saving". In order to clarify this situation CEMEP (the European Committee of Manufactures of Electric Machine and Power Electronic) and the European Commission have devised motor efficiency classification lable- Eff1, Eff2, Eff3 to make it much easier for purchasers to identify energy efficient motors on the market. The programme was implemented by a voluntary agreement between the commission and the motor manufactures to reduced sales of Eff3 motors by

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half by 2003. That target has been reached. Fig1.2 related the efficiency for these types of motors

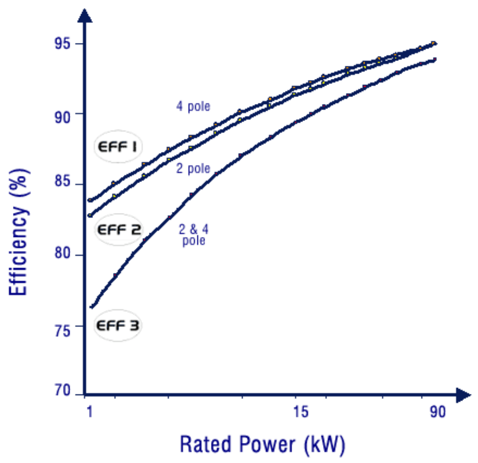


Fig 1.2 –Curves Efficiency –Rated Power

The term energy efficient is preferred by manufacturers in USA because it is recognized by NEMA as defined in NEMA Standards Publication MG 1-1993 *Motors and Generators*, and because it most clearly describes the feature of interest: energy efficiency.

B. Constructive description:-

EEM is manufactured using the same frame as a standard motor. But they have some differences:

- Higher quality and thinner steel laminations in the stator.
- More copper in the winding.
- Optimized air gap between the rotor and the stator.
- Reduced fan losses.
- Closer machining tolerances.
- A greater length.
- High quality aluminium used in the rotor frame.

C. Advantages

- The EEM has a greater efficiency than a standard motors: therefore they have less operating costs.
- EEM has a lower slip so they have a higher speed than standard motors.
- EEM can reduce maintenance costs and improve operations in industry due to robustness and reliability.
- Increasing of productivity.

D. Recommendations when applying EEM

EEM should be considered in the following cases:

- For all new installation
- When major modification are made to existing facilities or process.
- For all new purchases of equipment packages that contain electric motors.
- When purchasing spares or replacing failed motors.
- Instead of rewinding old standard motors.
- To replace grossly oversized and under loaded motors.
- As a part of an energy management or preventive maintenance program.
- When utility conservation programs. Rebates or incentives are offered that make energy efficient motor retrofits cost- effective.

E. Benefits when implementing Energy Efficient Motor

- Environmental benefit

One of the major current environmental concerns is the greenhouse gas emission (Co2, N2O…). After signing the Kyoto protocol, it must reduce overall green house gas emissions over the period of time.

- Micro economical benefits

The micro economical benefits are non-energy benefits that achieve due to implementing energy efficient motors such as:

- ➢ A better process control.
- ➢ A reduced disruption process,
- ➢ An improved product quality.
- ➢ Sometimes reliability is improved.

- Macro economical benefits

It is possible to consider three direct macro economical benefits

- ➢ Increased competitiveness.
- ➢ Raised employment.
- ➢ Reduced dependency of fossil fuels.

Using energy as efficiency as possible is a crucial requirement to maintain the competitiveness of the Indian economy.

The investments in energy efficient motors can create jobs in three areas: energy service companies manufactures of motors and jobs in energy or maintenance departments.

III. MOTOR SYSTEM TECHNOLOGY AND OPTIONS TO IMPROVE ENERGY EFFICIENCY

Electric motors are used in most industrial systems where mechanical energy is needed. They Convert electrical energy into rotary mechanical energy which is then further converted to ultimately provide the needed use-energy.

Depending on the industrial structure, electric motor systems account for about 60 to 70 percent of industrial electricity consumption. A typical classification of motor systems is shown in Figure 1.3 denoting the share of each motor system in the total electricity consumption of all motor systems in the USA.

Although the figures vary slightly by country, the general pattern is comparable in most countries. Pumping, compressed air and fan systems are some of the most electricity consuming motor systems.

Also, material handling and processing consume a lot of electricity, although these systems are more heterogeneous and differ from each other.

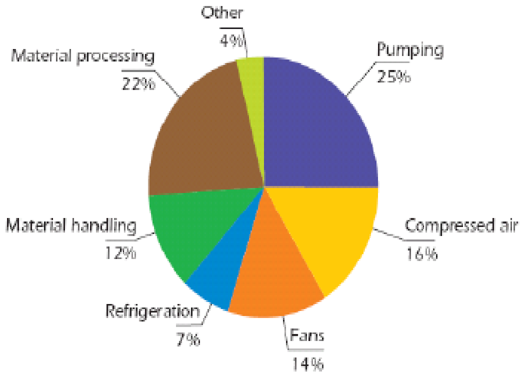


Fig.1.3 electric use by types of electrical motor.

While most of the electric motors used are induction motors1 and thus relatively comparable, the systems in which they are used vary strongly in terms of complexity as well as efficiency. Pumping, compressed air and ventilation systems often enjoy special attention, as they represent a large share of industrial electricity consumption and, at the same time, relatively high saving potentials.

Consequently, the system perspective is essential for the exploitation of energy savings in motor systems. In this document, the system definition by Brunner et al. (2007) is used. They distinguish between three kinds of motor systems:

1) The (fully functioning) electric motor itself.
2) The core motor system, which can comprise a variable speed drive, the driven equipment like a fan, pump or compressor and the connection, like a gear or belt.
3) The total motor system, which also includes ducting or piping systems and all possible end-use equipment like compressed air tools. It may also entail uninterruptible power supply.

IV. ENVIRONMENT AND TECHNICAL EVALUATION

Generally , energy efficient motors cost an average 15 to 30 percent more than standard motors. But it depends on the specific motor manufacturers and market competition. It is often possible to obtain a lower price premium when purchasing a large quantity of energy efficient motors. The price premium per horsepower is lower for the large motor ratings. The different prices between an energy efficient motor and a standard motor. An energy efficient motor is always more expensive than a standard motor, and this difference increase with size.

The payback period varies according to the purchase scenario under consideration, cost difference, hours of operation electrical rates, motor loading and difference in motor efficiencies. For new purchase decision or the replacement of burned –out and un rewind able motors. The simple payback period for the extra investment associated with an energy efficient motor purchase is the ratio of the price premium less any available utility rebates. To the value of the total annual electric savings.

$$\text{Simple payback years} = \frac{\textit{price premium} - \textit{utilityrebate}}{\textit{Total annual costs savings}} \quad \ldots\ldots(1)$$

For replacement of operational motors, the simple payback is the ratio of the full cost of purchasing and installing a new energy efficient motor relative to the total annual electrical savings. Simple payback years=

$$\frac{\textit{New motor cost} + \textit{installation charge} - \textit{utility rebate}}{\textit{Total annual cost savings}} \quad \ldots\ldots(2)$$

V. OUT LOOK DEVELOPMENT TECHNOLOGY

Although electric motors are a mature technology, certain improvements in energy efficiency are still expected. Currently, a new generation of motors with copper die cast rotors is being produced that will increase efficiency by some percentage points in comparison to standard technology. Compared to electric motors, electronic motor controls that allow for variable speed drives (VSD) are a fairly new technology that still has considerable market potential in coming years.

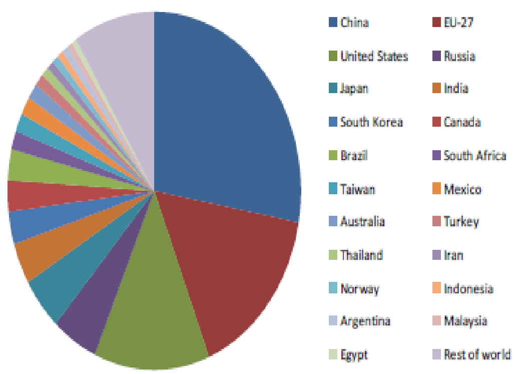
VI. QUANTITATIVE ASSESSMENT OF COSTS AND SAVING POTENTIALS

The importance of motor systems in industry's electricity consumption, this analysis aims to calculate motors' electricity consumption, saving potential and cost reduction potentials by country.

The calculation comprises the following steps:

1) Using electricity consumption data by industrial sub-sector and typical shares of electric motor systems by sub-sector to calculate the total electricity consumption by motor system and country.
2) The typical saving potential by motor systems is used to calculate the total saving potential of motor systems for each country in GWh per year.
3) Average electricity tariffs for industry are used to calculate related cost-savings.

The analysis in fig 1.4 is conducted for the 21 countries or world regions with the highest industrial electricity consumption.



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VII. ACTUAL CASE STUDY

Objectives of Study **:-**
1) To find out % energy saving by Rotomotive make New Motors.
2) To Search out the other energy conservation opportunities in the company.

General remarks:-
- 4 Motor of 3.7 Kw (2 Rotomotive & 2 Old Motor) were
- Tested. Speed of 7 old motors & 2 Rotomotive motors were measured.
- Power Factor Correction measurers were observed.

VIII. OBSERVATION

(1) SPEED:- As the old motor s are repeatedly rewounded, the speed range was around 1435 to 1440 while in case of Rotomotive motors the range is 1464 - 1470. These is a clear cut difference of 20 to 30 RPM and the load was speed sensitive. There should be increase in production in case of new motor. As the speed is higher, new motor suppose to draw more power because of higher speed and higher production.
(2) Efficiency of motor :- There is a difference of 3 % in efficiency in old motor and new motor were calculated with the new motors having higher efficiency.
(3) Power Factor : -There was no power factor correction measures were taken at section level.

IX. CALCULATION OF ENERGY SAVING & PAY BACK

1) Existing old motor : 81% Efficiency , 75 % loading

Input power (kw) = $\frac{3.7 \text{ kw X } 75\%}{81\ \% \text{ Efficiency}}$ = 3.42 kw

Energy usage = 3.42 $\times$ 8760 hours/year
= 29960 kWh per year

1) Rotomotive new motor :
84.7 % Efficiency, 75 % loading Energy Charges= Rs. 5 per kwh

Input power (kw) = $\frac{3.7 \text{ kw X } 75\%}{84.7\ \% \text{ Efficiency}}$ = 3.27 kw

Energy usage = 3.27 $\times$ 8760 hours/year
= 28645 kwh per year

SAVING =(29960 - 28645) = 1315 kwh / year per motor

Simple payback $\frac{Cost\ of\ motor}{saving} = \frac{7000(Approx)}{1315 \times 5}$ =1 year

2) Energy Efficient Motor(EFF-1), as per IS-12615: 88.3 % Efficiency, 75 % loading , Energy Charges= Rs. 5 per kwh.

Input power (kw) = $\frac{3.7 \text{ kw X } 75\%}{88.3\ \% \text{ Efficiency}}$ = 3.14kw

Energy usage = 3.14 $\times$ 8760 hours/year = 27506 kwh per year

SAVING =(29960 - 27506) = 2454 kwh / year per motor

Simple payback = $\frac{Cost\ of\ motor}{saving} = \frac{8200\ (Approx)}{2454 \times 5}$ =8 month

X. CONCLUSION.

Energy efficiency potentials in industrial motor systems are massive, in particular if a system optimization approach is pursued. Furthermore, many of the energy efficiency investments have payback times of a few years only. With the practical cases, it can be noticed that EEM is more efficient than standard motor are rewound Motor. Also. energy savings can be regained in five years or less. To sum up this paper has tried to stress that energy efficient motor lead to save a very significant amount of energy. Developing countries with high growth rates and a fast growing industry can benefit from policies for energy efficient motor systems. Still, in both developed and developing countries, the policies in place are insufficient to exploit the energy efficiency potentials of motor system optimization.

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