Energy Conversion by Using Energy Efficient Motor (Case study of sugar industry)

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ABSTRACT

India's Power Sector facing the acute problem of meeting growing demand of electricity. Improving energy efficiency by employing energy efficient device would be better alternative for meeting part of new demand. Three phase induction motor for significant load in industrial sector .instead of used generally used standard motor, if energy efficient motor are used, it will result into substantially saving in energy. Energy efficient motor (EEM) gives more efficiency over standard motor (STM).

This paper deals with energy conservation by installing energy-efficient motors (EEM) instead of standard efficiency motors. This transition become a necessity as a direct result of limitation in energy sources and escalating energy prices. As electric motors use about three quarters of the total electric energy in Indian state of Gujarat, attempts to conserve the energy consumed by electric motors recently received intensive research efforts. Therefore, the energy efficiencies of energy efficient motors are compared with those of standard efficiency motors ranging from 5 to 200 HP. To provide more clarification in this regard, full design details of 7.5 HP standard-efficiency and energy-efficient motors are compared. Pay back periods when replacing standard-efficiency motors with energy-efficient motors, with reference to ***Mahuva sugar factory*** *Surat, Gujarat, and case study have been discussed. [1] [9]*

Keyword: - *Energy efficient motor, Induction motor, energy consumption, energy saving, energy efficien*

1. Introduction

In the future, the cost of energy will increase due to environmental problems and limited resources. The Electric 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.

2. Energy Efficient Motor (EEM)

Energy-efficient motors are constructed with improved manufacturing techniques and superior materials, they usually have higher service factors, longer insulation and bearing lives, lower waste-heat output, and less vibration — all of which increase reliability. It consist of EFF1 & EFF2. EFF1 is energy efficient with a safety factor and EFF2 is the high energy efficient standard motor [2]

(Courtesy: copperindia.org**)**

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 label- 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 half by 2003. That target has been reached. Fig1.1 related the efficiency for these types of motors 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.

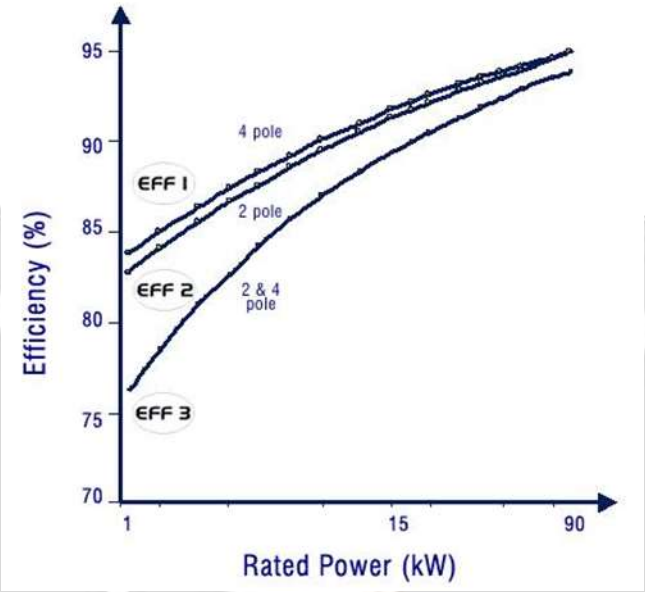

Fig 1 –Curves Efficiency –Rated Power [3]

2.1 Energy Efficient Motor VS Standard Motor

Same frame is used for manufacturing of as a standard motor as well as EEM.
But following points are differentiate them from each other:

- Grater quality and thin laminations of steel used 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 aluminum used in the rotor frame.

2.2 Merits of EEM

- 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.

2.3 Cases in which EEM is frequently installed

- For all new installation
- When major modification are made to existing facilities or process

- cc 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. [4]

2.4 Rewards of implementing EEM

i. **Environmental rewards**

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

ii. **Micro economic rewards**

a. The micro economic rewards are non-energy rewards that achieve due to implementing energy efficient motors such as:
b. A better process control.
c. A reduced disruption process,
d. An improved product quality.
e. Sometimes reliability is improved.

iii. Macro-economic rewards

a. It is possible to consider three direct macro-economic rewards
b. Increased competitiveness.
c. Raised employment.
d. Reduced dependency of fossil fuels.
e. 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.

***iv.* Fixing common mistakes**

There are many misunderstanding about the characteristics of energy efficient motors. Some of them lead users to expect more than they will deliver. For example:

a. An oversized motor is less efficient.
b. A more efficient motor also has higher power factor.
c. More efficient motors run cooler.
d. An energy efficient motor develops less torque, and may not accelerate the load.

***v.* Economical 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.[5] [6] [7]

Simple payback year = $\frac{Price\ premium - Utility\ rebate}{Total\ Annual\ cost\ savings}$ _____ (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 year = $\frac{New\ motor\ cost + Installation\ charge - Utility\ Rebate}{Total\ Annual\ cost\ savings}$ _____ (2)

3. Practical Cases

The case study of Mahuva Sugar mill Limited

Objectives of Study:

To find out % energy saving by Crompton make New Motors.
To Search out the other energy conservation opportunities in the company.

General remarks:

4 Motor of 5.5 kW (2 Crompton & 2 Old Motor) were Tested. Speed of 7 old motors & 2 Crompton motors were measured. Power Factor Correction measurers were observed.

Observations:

1) SPEED:

As the old motor s are repeatedly rewounded , the speed range was around **1435 to 1440** while in case of Crompton 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 supposed 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.

3.1 CALCULATION OF ENERGY SAVING & PAY BACK:

***A.* Existing old motor:**

81% Efficiency, 75 % loading

Input Power (kW) $=\frac{7.5\ kW \times 75\%}{81\%\ Efficiency}$ = 6.94 kW

Energy usage= 6.46 × 8760 hours/year

60794 kWh per year

***B.* Crompton new motor :**

84.7% Efficiency, 75% loading Energy Charges= Rs. 5 per kWh

Input power (kW) = $\frac{7.5\ Kw \times 75\%}{84.7\%\ Efficiency}$ = 6.64 kW

Energy usage= 6.64 × 8760 hours/year

= 58166 kWh per year

Saving = (60794 – 58166) = 2628 kWh/ per motor

$$\text{Simple Payback} = \frac{Cost\ of\ Motor}{Saving} = \frac{14000(Aprrox.)}{2628\times5} = 1\ \text{Year}$$

C. Energy Efficient Motor(EFF-1), as per IS-12615:

88.3 % Efficiency, 75 % loading,
Energy Charges= Rs. 5 per kWh

Input Power (kW) $= \frac{7.5\times75\%}{88.3\%\ Efficiency} = 6.37$ kW

Energy usage= 6.37 × 8760 hours/year

= 55801 kWh per year

Saving = (60794 – 55801) = 4993 kWh/ per motor

$$\text{Simple Payback} = \frac{Cost\ of\ Motor}{Saving} = \frac{15200(Aprrox.)}{4993\times5} = 6\ \text{Months}$$

4. CONCLUSIONS

The analysis presented shows that energy efficient motors are opportunity for improving the efficiency of motor system, leading to large cost effective energy savings. Improving of the industrial economic efficiency and reducing the environmental impacts. In spite of their advantages, these motors find barrier in the market that stop their penetration a large scale. These barriers are being overcome thanks to different strategies such as education, training, financial, incentives, labeling and others.
With the practical cases, it can be noticed that EEM is more efficient than standard motor and 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. [8]

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