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Use of Energy Efficient Electric Motors in Rice Mill Industry: A Case Study

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***Abstract*—In this paper, benefits of energy efficient over standard efficiency motors, in terms of energy saving are evaluated. Today India is facing energy crisis. The industry is the main consumer of energy with the major load component being of motors. Three phase squirrel cage type induction motor is the most commonly used motor in industries in India. Since energy requirements are growing day by the day, it is becoming increasingly important to save energy in industries.Energy conservation reduces the demand.Rice Mill is a potential energy saving area in the State of Punjab. Induction motors being the main energy consumer in this industry offer opportunity of energy saving. Samrala Division of Punjab State has been taken for analysis.A survey had been conducted on 31 Rice-Mills in 7 Sub Divisions of Samrala Division, Punjab. The data included the energy consumption by the existing motors on monthly basis. The load data for the various Rice-Mills of this Division has been taken into account. The parameters associated with the already installed induction motors have been noted for the calculation of efficiency and reactive power requirements. A proposal has been made to replace the conventional induction motor with energy efficient motors. The losses and efficiency of energy efficient motors are calculated and it is compared with already existing conventional motors. In this paper a comparative analysis is done on efficiency and operating cost of Standard Efficiency Induction motors and Energy Efficient motors. The savings resulting with the replacement of Standard Efficiency with Energy Efficient motors are shown. The payback period for the Samrala Division and then for the whole State of Punjab has been calculated. In this paper, a case study showing these benefits has been presented.**

***Index Terms*— Energy saving, Operating cost, Energy Efficient Motors, pay-Back period.**

I. INTRODUCTION

The motor efficiency can only be increased by reducing motor losses. A three phase squirrel cage induction motor having an efficiency of 92% requires 25% loss reduction for 2% efficiency improvement. Generally, motor insulation life doubles for each 10°C reduction in operating temperature. In poly-phase induction motors, slip is a measure of motor winding losses. The lower is the slip, the higher is the efficiency. Less slippage in EEMs results in speeds about 1% faster than in standard efficiency motors. The loss difference is small for small hp ratings of motors but this loss difference increases with increase in the hp rating of the motors. To reduce the losses associated with magnetic flux densitylength of EEM rotor and stator cores is more, so the length of EEM motors is more than the standard efficiency motors. Efficient Motors (EEMs)

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cost an average 15 to 30% more than standard motors; it varies with the rating of the motor. As the number of poles in a motor increases its price also increases because the frame size of the machine increases. The more cost of the EEMs is paid back in certain period of time due to reduced operating cost. The payback time can be calculated.EEMs have better performance due to the following reasons:

- using lower electrical-loss steel,
- increased core length ,
- thinner stator laminations,
- more copper in the windings,
- improved bearings,
- better aerodynamic cooling fan

These modifications result in numerous benefits. EEMs have longer insulation life,lesser vibrations,lower waste heat output, higher power factor, extended lubrication cycles due to cooler operation, better tolerance to thermal stresses resulting from stalls or frequent starting.Higher power factor in the cases of EEMs reduces the system losses and utility power factor surcharges.

II. Demand Reduction

The main objective of this paper is to show the Demand reduction and the conservation of energy and with the implementation of EEMs in place of conventional induction motors which are already used to drive the Rice-Mills in the Samrala Division of Punjab State.
For the implementation of EEMs the practical cases of different Rice-Mills of the Samrala division of Punjab State have been taken. Three phase cage type induction motors are used there. In some of the cases the old motors from ships are being used and in most of the cases standard efficiency motors are being used in the Rice-Mills. The savings and payback calculations are worked out for the commonly used power ratings of the inductions motors. Replacing standard efficiency motors with EEM would result in huge savings in electrical energy consumption bills, as well as in the reactive power. The saving in kVAr by the use of EEMs improves the voltage profile of the electrical power transmission system

III. Methodology

- Collection of energy consumption data of thealready installed conventional motors in various Rice-Mills of Samrala Division of Punjab State.
- Calculation of losses of standard motors and EEMs.
- Comparison of Reactive Power for both the standard and EEMs
- Calculation of the payback period and do the cost analysis.
- Presentation of the advantages of using EEMs from consumer as well as utility point of view.

Case Study: A survey had been conducted on thirty one (31) Rice-Mills in seven (7) subdivisions of Samrala Division, Punjab. The main objective is to save electric energy by improving the efficiency by replacing the commonly used three phase induction motors with high efficiency motors. For the same output as that of standard efficiency induction motors, energy-efficient motors consume lesser power and have better power factor. The data from the various subdivisions of the Samrala Division in the state of Punjab has been collected with help of SamralaPowercom offices. For the commonly used motor ratings, various parameters have been calculated, both for standard and EEMs. These parameters are being presentenced graphically and in a tabulation form systematically.

TABLE I. COMPARISON TABLE FOR 30 HP, 6 POLE AND 1000 RPM MOTORS

Parameters	Standard Motor	Energy-Efficient motor	Difference
Efficiency(FL)	89%	91.8 %	2.8 %
P.F. (FL)	0.79 lagging	0.84 lagging	0.05
Current (FL)	44.28 A	40.38 A	3.9A
Voltage	415 V	415 V	-
kVA (Input)	31.830	29.023	2.807 kVA
kW (Input)	25.146	24.379	0.767 kW
kVAr (Input)	19.515	15.749	3.766 kVAr
Price (Rs.)	126530	139180	Rs. 12650/-

Life of Motor	15 yrs
Energy rate per Kwh	Rs. 5.60/-
Working hours	22
Working days in a year	245

Calculations:

$$Savings = \left(\frac{kW}{E_1} - \frac{kW}{E_2} \right) \times (Working\ hours) \times (Working\ days) \times (Tariff)$$

kW = Output of motor in kW
E_1= Efficiency of standard motor
E_2= Efficiency of Energy-Efficient motor
Annual savings for 30 hp motors

$$= \left(\frac{30 \times 0.746}{0.79} - \frac{30 \times 0.746}{0.84} \right) \times (22) \times (245) \times (5.6) = 50898$$

Extra amount for efficient motor = 12650
Payback period = Extra amount / annual saving = 12650 / 50898 = 0.249 Yrs or 3 months

Savings for 15 years = 15 × 50898 = Rs. 763470/-

TABLE II. COMPARISON TABLE FOR 75 HP, 4 POLE AND 1500 RPM MOTORS

Parameters	Standard Motor	Energy-Efficient motor	Difference
Efficiency(FL)	92%	94.2 %	2.2 %
P.F. (FL)	0.86 lagging	0.88 lagging	0.02
Current (FL)	98.38 A	93.90 A	4.48 A
voltage	415 V	415 V	-
kVA (Input)	70.715	67.495	3.220 kVA
kW (Input)	60.815	59.395	1.420 kW
kVAr (Input)	36.085	32.069	4.026 kVAr
Price (Rs.)	264210	290630	Rs. 26420/-
Life of Motor		15 yrs	
Energy rate per Kwh		Rs. 5.60/-	
Working hours		22	
Working days in a year		245	

Calculations:
Using the formulas as given above:
Annual savings for 75 hp motors

$$= \left(\frac{75 \times 0.746}{0.92} - \frac{75 \times 0.746}{0.942} \right) \times (22) \times (245) \times (5.6) = 42871$$

Extra amount for efficient motor = 26420
Payback period = Extra amount / annual savings = 26420 / 42871 = 0.616 Yrs or 7.4 month appx.

Savings for 15 years = 15 × 42871 = Rs. 643065/-

The use of EEMs in Samrala Division only is resulting in annual savings of Rs. 32 Lakhs approximately and reactive power savings of 177 kVAr. The extra amount required for the EEMs can be recovered in small time period of 4 months approximately.
There are about 3000 Rice-Mill in the state of Punjab. The average power rating of motors is 75 hp. If we consider 22 working hours and 245 working days on the average, annual energy savings are more than Rs. 12 crores and annual reactive power savings becomes more than 12000 kVAr with additional benefit of

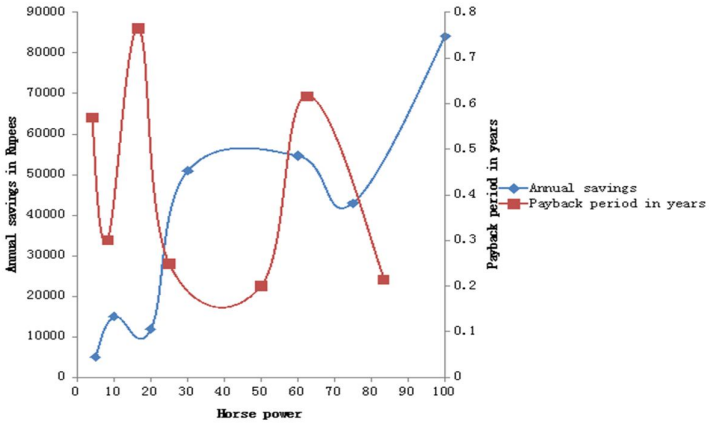

Figure 1 Annual energy bill savings by EEMs and payback time

improved voltage profile of electrical power transmission system. The payback period is 7 months approximately.

IV. Payback Analysis

The additional cost related with selecting EEMs may be easily returned in the form of lowered energy costs and high performance. Mostly inefficient motors are selected on the basis of purchase price without concern for the lifecycle cost. As energy prices continue to increase and environmental laws continue to strengthen, it is necessary to look closely at equipment efficiency. This report reflects upon the preliminary study done on the electrical energy saving by using EEMs. There is further scope of study of energy saving by the use of individual drive system instead of group drive system. Work should be done to optimize the motor design for more and more reduction of losses and the motor cost.

V. Conclusion

It is seen that with use of energy efficient motors, the electricity usage comes down and so does the cost of electricity. The pay back periods are attractive. For major high rating continuous working motors, it is recommended that the industry should switchover to energy efficient motors at the ealriest

References

[1] Andreas John C., "Energy efficient motors selection and application", Second edition, *Marcel Dekker, Inc*, New York, Basel, Hong Kong, 1992.

[2] A. H. Bonnet, "Reliability comparison between standard and energy efficient motors", *IEEE Transactions on industry applications*, Vol.33, No.1, pp.135-142, January/February 1997.

[3] Colby, R.S. and Flora, D.L. "Measured efficiency of high efficiency and standard induction motors", *IEEE Transactions*, Vol. 1, pp.18-23, Oct 1990.

[4] Corino S, Romero E and Mantilla L.F "Energy Savings by means of Energy Efficient Electric Motors" Department of Electrical Engineering and Energy E.T.S.I.I. y T. Universidad de Cantabria Avda de Los Castros, 39005 Santander (Spain).

[5] Hassan M.Y.,MajidM.S.andRahmanH.A. "Application of Energy Efficient Motor in Malaysian Industries", *TENCON proceedings 2000,*vol. 2, pp.97-102.