Efficiency of Rewound Induction Motors in a Sugar Mill

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ABSTRACT

To reduce energy consumption in any industry, it is necessary to determine the efficiency of rewound induction motor and compare it with the rated efficiency of that motor. If the efficiency of rewound induction motor is found near to the rated efficiency of that motor, then there is no need for any change. If the efficiency of rewound induction motor is found low as compared to rated efficiency of that motor, then it is better to replace that motor with new one. This paper explains the analysis done on rewound induction motors to determine the efficiency and comparison is done with new one. After analyzing, it was found that the payback period of rewound induction motors when replaced by new ones, exist within the range of 1.5 years to as less as 7 months.

Keywords

Rewound induction motors, sugar mill, efficiency, energy losses, payback period

1. INTRODUCTION

We ask that authors follow some simple guidelines. In essence, we ask you to make your paper look exactly like this document. The easiest way to do this is simply to download the template, and replace the content with your own material. The major source of energy consumption in an industry is electrical motors. About 70% of energy is consumed by induction motors in a sugar mill. It is a common practice in any industry to rewind the induction motors in case of any fault. This decreases the efficiency of a motor and increases the energy losses and hence the energy consumption in any industry. Thus, it is better to replace the rewound induction motors with the new ones.

2. PROBLEM DEFINITION

In the sugar mill, the rewound induction motors of different horsepower are to be studied for different types of losses so as to determine the overall efficiency of the induction motors. Then, these efficiencies are compared with the efficiencies of new induction motors. After that, it has been found that it is better to replace the rewound induction motors with the new ones as the payback period is found to be existing in the range of 1.5 years to as less as 7 months.

3. METHOD

After visiting in the sugar mill so many times, several rewound induction motors are identified. After that, it is being examined that how the machines are working. Then all the parameters (rated, measured and calculated) of the motors are recorded through different measuring instruments. These parameters are then used for determining the efficiency of the induction motors. The equipments used for the measurements of induction motor parameters are described in table 1.

Table-1 Parameters and Measuring Instruments used

Parameters	Measuring Instruments
Voltage	Power Analyzer
Current	Clamp On Transducer
Input Power	Power Analyzer
Speed	Tachometer
Winding Temp.	Resistance Temperature Detector
Winding Resistance	Power Analyzer

Fig.1 is showing the procedure for analyzing the motor behaviour

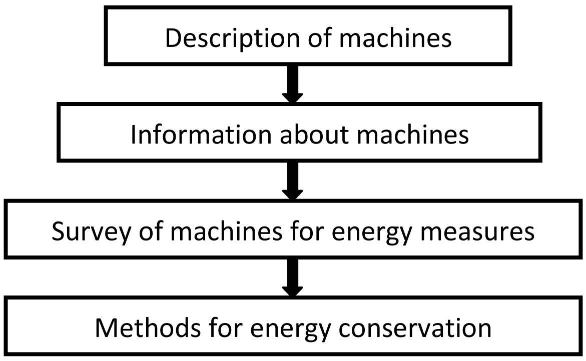

Fig-1 Process Flow Chart for Analyzing the Motor

4. RESULTS AND DISCUSSIONS

The energy can be saved by means of replacing the rewound induction motors with the new ones so as to increase the efficiency of the motor. Rated parameters of one of the induction motors are shown in table 2.

Table- 2 Rated Parameters

No. of Phases	03
No. of Poles	04
Rated Power(HP)	7.5
Rated Voltage, (Vrated)	415
Rated Current, (Irated)	12
Full Load Rated Speed, (Nrated)	1440
Supply frequency, f (Hz)	50

Measured parameters of one of the induction motors are shown in table 3.

Table- 3 Measured Parameters

No-load voltage, $V_{no-load}$(V)	410
No-load current, $I_{no-load}$(A)	4.74
No-load input Power, $P_{no-load}$(W)	851.7
Winding Temp. of still motor, T1(°C)	40
Resistance at room temp., R1(W)	0.85
Winding Temp. of no load motor, T2(°C)	40
Winding Temp. Of loaded motor , T3(°C)	123
Supply frequency, f (Hz)	50
Full load voltage, $V_{full-load}$(V)	410
Full load current, $I_{full-load}$(A)	16
Full-load input Power, $P_{full-load}$(W)	7953.3
No-load Speed, N1(RPM)	1475
Full-load Speed, N2(RPM)	1460

5. CALCULATED PARAMETERS

Synchronous speed, $Ns = \frac{120f}{p} = \frac{120*50}{4}$ = 1500RPM

Stator resistance of no-load motor,

$$R2=R1*\frac{235+T2}{235+T1}=0.85\times\frac{235+41}{235+40}=0.85\ \Omega$$

Stator resistance of loaded motor,

$$R3=R1*\frac{235+T3}{235+T1}=0.85\times\frac{235+123}{235+40}=1.10\Omega$$

Stator cu. loss, Pst1 = (Ino-load)2 × R1 = 19.1 W

Stator cu. loss, Pst2 = (Ifull-load)2 × R2 = 281.6 W

Iron and F&W losses, (Pi + Pf&w) = Pno-load – Pst1 = 832.6 W

No-load slip, Sno-load (%) = $\frac{Ns-N1}{Ns}*100$ = 1.67

Full-load slip, Sfull-load (%) = $\frac{Ns-N2}{Ns}*100$ = 3

Full-load rotor losses, Protor = (Sfull-load/100) × ($P_{full-load}$–Pst – P_i – $P_{f\&w}$) = 205.1 W

Stray losses= 0.0168* P_{rated}= 126W

Full load output power= $P_{full-load}$ – P_{stray} – P_{rotor}– (P_i+$P_{f\&w}$)- $P_{full-load}$ = 6508

Efficiency at full-load, , ηfull-load = (P_{output}/$P_{full-load}$) × 100= 81.8%

Rated Efficiency= 90.7%

Determined Efficiency of an analyzed new motor = 86.8%

After comparing the new motor with the analysed rewound motor, simple payback period obtained = 1.10 Years

Analysis done on few rewound motors according to the formulae described above is shown below in the form of graphs:

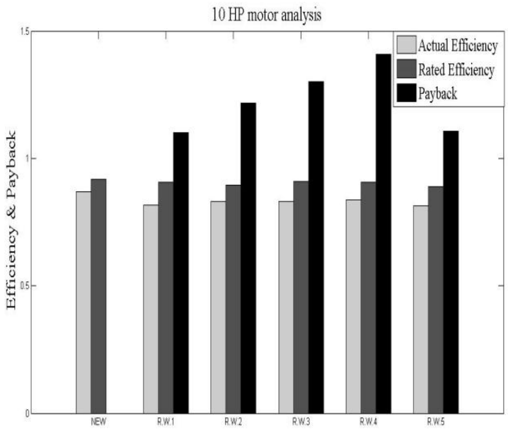

Fig-2: 10 HP motor analysis

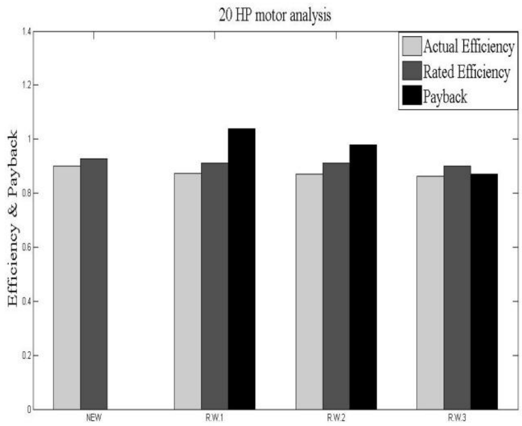

Fig-3: 20 HP motor analysis

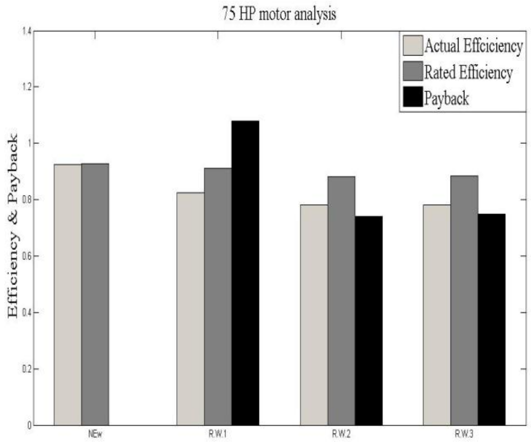

Fig-4: 75 HP motor analysis

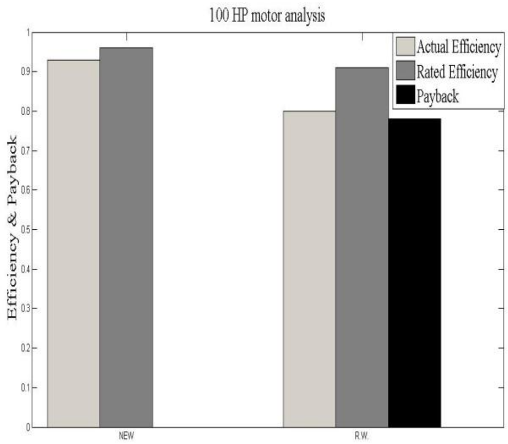

Fig-5: 100 HP motor analysis

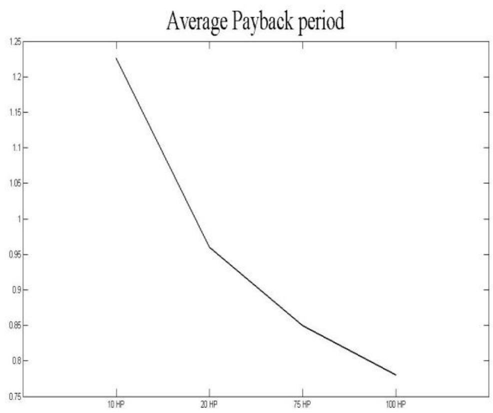

Fig-6: Average payback analysis

After doing analysis of rewound motors, it is recommended to replace the motors with new motors. It is noticed after analysis that there exists a relationship between motor horsepower and its payback period. The relationship is stating that with the increase of the motor size its payback period decreases.

Hence, it is recommended to replace the large horsepower motors than to make them rewound.

6. CONCLUSION AND FUTURE SCOPE

The most energy conservation area is analyzing the rewound motors and after analyzing, it was found that it is better to replace the rewound motors with new ones as the payback period for these motors after comparing with new ones is very less i.e. 1.5 years to 7 months.

Capacitor bank of determined size can also improve the system efficiency. The losses of the system are reduced. Hence play an important role in conservation of energy. A future study on power factor improvement analysis and improvement is thus suggested.

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