Myth Associated with Rewound Induction Motor-An Analysis

Keerti Rai[1] S B L Seksena[2] A N Thakur[3]

Research Scholar *Professor* *Professor*

Department of Electrical Engg., NIT, Jamshedpur

Abstract

Induction Motors (IM) are the horse power of any industry and they consume most of the energy. To reduce energy consumption, it is necessary to find a way for energy saving and for sustainable development. In this paper an attempt has been made to remove this myth which is associated with rewound induction motor, by an analytic approach. If the efficiency of rewound motor is found approaching to that of new motor, rewound motor may be proffered as replacement for the new one. This paper explains the approach carried on investigating the individual efficiency of rewound IM as well as that of the new motor. On the basis of the analysis, efficiency of new motor compared with that of the rewound induction motor and it has been investigated that rewound motor up to a rating of 15 hp may be recommended as an replacement for the new motor at full load.

Keywords: *Rewound Induction Motor, New Induction Motor, Efficiency.*

1. Introduction

The major source of energy consumption in an industry is electrical motors. About 70 percent of energy is consumed by induction motors in industries hence, it is important to focus on energy saving. If winding of induction motor is burnt at early stage, there is need for replacement and there are two options for it ,i.e either to purchase a new induction motor or to rewind the same motor. There is a myth associated with rewound induction motor that it is not efficient as the new motor, owing to high running cost & not suitable for sustainable development. In this paper the rewound IMs of different horsepower were analyzed for all types of losses to determine their efficiencies. These efficiencies of both the induction motors (Rewound and New) are compared, which reveals that the replacement of rewound induction motor for new motor is an viable option which helps not only in energy saving but also sustainable development may also be achieved successfully.

2. Method

The parameters (rated and measured) of the motors are recorded. These parameters are then used for determining the efficiencies of the induction motors (Rewound and New). The instrument used for measurement of the parameters are described in Table 1 below;

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

Table1. Parameters and Measuring Instruments Used

To analyze the machine some strategies are to be followed. Fig.1 shows the procedure for analyzing the motor behavior [6]. Rated Parameters of 3- phase, 4 poles. 50 Hz Induction motor is given Table2.

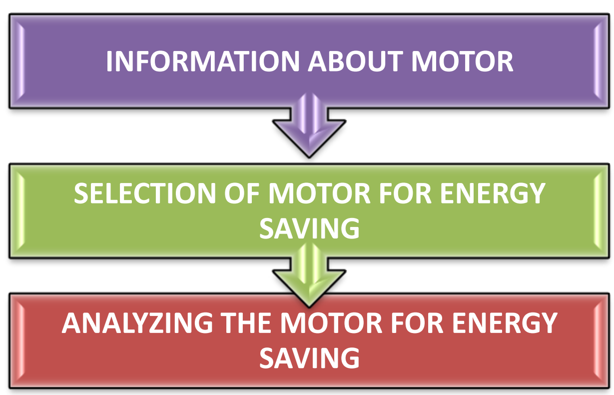

Fig.1 Procedure to Analyze the Motor

The Parameters (measured and calculated) of New and Rewound Induction Motors are shown in Table 2 and Table3

Rating of Motor (HP)	New/Rewound IM	Power (kW)	Voltage (V)	Current (A)	Speed (RPM)
15	New	12	415	19	1460
	Rewound	12	415	19	1460
20	New	15	415	20	1460
	Rewound	15	415	20	1460
50	New	37	415	62	1480
	Rewound	37	415	62	1480
100	New	75	415	122	1480
	Rewound	75	415	122	1480

Table. 2 Rated Parameters of New and Rewound induction motor

.

Rating of Motor (HP)	New/ Rewoud IM	No Load Current I_{nl} (A)	No Load Speed N_1 (RPM)	Winding Temp. of Still Motor T_1 (◦C)	Resistance at Room Temp. R_1 (Ω)	Winding Temp. of No Load Motor T_2 (◦C)	Winding Temp. of Full Load Motor T_3 (◦C)
15	New	15.00	1480	13	0.5	34	140
	Rewound	13.00	1480	15	0.8	43	142
20	New	17.00	1490	23	0.25	39	137
	Rewound	14.00	1490	25	1.20	41	141
50	New	27.00	1495	27	0.11	39	110
	Rewound	22.00	1490	30	0.87	43	141
100	New	81.00	1495	40	0.05	43	120
	Rewound	79.00	1495	42	0.45	46	132

Table. 3.1 Measured Parameters of New and Rewound induction motor

Rating of Motor (HP)	New/Rewound IM	Full Load Voltage vFL(V)	Full Load Current Ifl (A)	Full Load Input Power Pfl(Kw)	Full Load Speed N2 (RPM)	No Load Input Power Pnl (W)
15	New	415.00	24.00	13.50	1475	523
	Rewound	410.00	25.00	13.50	1470	589
20	New	415.00	32.00	15.00	1475	615
	Rewound	410.00	34.00	17.30	1475	660
50	New	415.00	66.00	41.00	1485	1290
	Rewound	415.00	68.00	43.00	1480	1800
100	New	415.00	100.00	85.00	1485	2700
	Rewound	415.00	105.00	85.50	1485	3000

Table. 3.2 Measured Parameters of New and Rewound induction motor

Calculated Parameters for 15 HP Rewound Induction motor at full load;

Synchronous speed, $Ns = \frac{120 \times f}{P} = \frac{120 \times 50}{4}$
$= 1500$ rpm

Stator resistance at no-load,

$$R_2 = R_1 \times \left(\frac{235 + T_2}{235 + T_1}\right) = 0.80 \times \left(\frac{235 + 43}{235 + 15}\right) = 0.89\ \Omega$$

Stator resistance at load,

$$R_3 = R_1 \times \left(\frac{235 + T_3}{235 + T_1}\right) = 0.80 \times \left(\frac{235 + 142}{235 + 15}\right) = 1.21\ \Omega$$

Stator Copper. loss,

$$P_{st1} = (I_{nl})^2 \times R_2 = 13^2 \times 0.89 = 150.34\ W$$

Stator Copper. loss,

$$P_{st2} = (I_{fl})^2 \times R_3 = 25^2 \times 1.21 = 754.00\ W$$

Iron + Friction & Windage losses,

$$(P_i + P_{fw}) = (P_{nl} - P_{st1}) = (589 - 150.34) = 438.66\ W$$

No-load slip,

$$S_{nl}(\%) = \left(\frac{N_s - N_1}{N_s}\right) \times 100 = \left(\frac{1500 - 1480}{1500}\right) \times 100 = 1.33\%$$

Full-load slip,

$$S_{fl}(\%) = \left(\frac{N_s - N_2}{N_s}\right) \times 100 = \left(\frac{1500 - 1475}{1500}\right) \times 100 = 2\%$$

Full-load rotor loss,

$$P_r = \left(\frac{S_{fl}}{100}\right) \times (P_{fl} - P_{st2} - P_i - P_{fw})$$
$$= \left(\frac{2}{100}\right) \times (13500 - 754.00 - 438.66)$$
$$= 246.15W$$

Stray losses,

$$P_{stray} = (0.015 \times P_{fl}) = (0.015 \times 13500) = 202.5W$$

Full-load output power,

$$P_{output} = (P_{fl} - P_{stray} - P_r - P_{st2}) = (13500 - 202.5 - 246.15 - 754.00) = 12297.35W$$

Efficiency at full-load,

$$\eta_{fl} = \left(\frac{P_{output}}{P_{fl}}\right) = \left(\frac{12297.35}{13500}\right) = 91.09$$

After comparing this efficiency of the rewound induction motor with efficiency of new induction motor, On the basis of above calculations it is found that there is not so much difference in both the efficiencies.

Same procedure is applied to all the motors. Table 4 shows the calculated parameters for different rating of motors.

Rating of Motor (HP)	New/Rewound IM	Synchronous Speed N_s(RPM)	Stator Resistance of No load Motor R_2 (Ω)	Stator Resistance at Load R_3 (Ω)	Stator Cu. Loss at No Load P_{st} (W)	Stator Cu. Loss at Full Load P_{st2} (W)
15	New	1500	0.54	0.76	122.03	435.48
	Rewound	1500	0.89	1.21	150.34	754.00
20	New	1500	0.27	0.36	76.73	369.12
	Rewound	1500	1.27	1.74	249.67	2006.10
50	New	1500	0.12	0.14	83.86	630.95
	Rewound	1500	0.91	1.23	441.74	5707.94
100	New	1500	0.05	0.06	331.63	645.45
	Rewound	1500	0.46	0.60	2849.01	6573.21

Table 4.1 Calculated Parameters of New and Rewound Induction Motor at different rating

Rating of Motor (HP)	New/Rewound IM	Iron and F &W Losses Pi+Pf&w (W)	No Load Slip Snl (%)	Full Load Slip Sfl (%)	Full Load Rotor Losses Pr (W)	Stray Losses Pstray (W)	Full Load O/P Power Poutput (W)	Efficiency at Full Load η (%)
15	New	400.97	1.33	1.67	211.06	202.50	12650.96	93.71
	Rewound	438.66	1.33	2.00	246.15	202.50	12297.35	91.09
20	New	538.27	0.67	1.67	234.88	225.00	14171.01	94.47
	Rewound	410.33	0.67	1.67	248.06	259.50	14786.34	85.47
50	New	1206.14	0.33	1.00	391.63	615.00	39362.42	96.01
	Rewound	1358.26	0.67	1.33	479.12	645.00	36167.95	84.11
100	New	2368.37	0.33	1.00	819.86	1275.00	82259.68	96.78
	Rewound	150.99	0.33	1.00	787.76	1282.50	76856.53	89.89

Table 4.2 Calculated Parameters of New and Rewound Induction Motor at different rating

Comparison of the efficiencies of the new and rewound induction motors are shown in Table 5. The results in Table 5 have been expressed in Figure 2 in a more convening way.

HP	Efficiency of New Motor	Efficiency of Rewound Motor
15	93.71	91.09
20	94.47	85.47
50	96.01	84.11
100	96.78	89.89

Table 5 Comparison of the efficiency of New and Rewound induction motor.

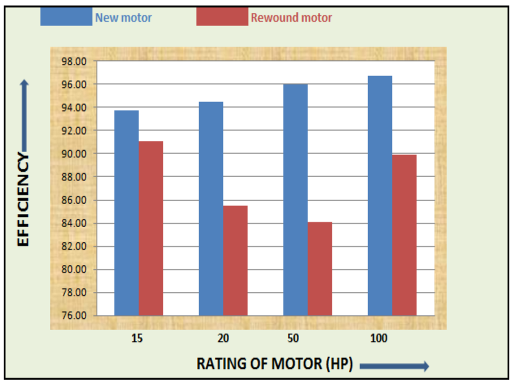

Fig. 2 Efficiency vs Rating of New and Rewound IMs

3. Results and Discussions

It is investigated after analysis the Efficiency of the rewound motor varies. The results shown in Table5, for 15 hp there is not so much difference, but as goes to higher rating of motor the variation of efficiencies increases. On the basis of these results it can be recommended that, for lower rating of motor (up to 15 hp) rewound IM may be used as replacement.

The multiple rewinds adopting the best practices may also improve efficiency of the rewound induction motor slightly by a margin of 0.2 percent but at the cost of multiple rewound attempts.

4. Conclusion

Efficiency decreases by the use of rewound IM is proved to be an absolute myth. After analysis carried out in this paper, it is found that for low rating of induction motor i.e up to 15hp rewound IM may be preferred for replacement of a faulty induction motor (w.r.t winding) by a new one.

5. Acknowledgment

The authors would like thank and express their gratitude to Electrical Engg. Dept. and Computer Center of NIT Jamshedpur fore extending valuable technical support require to carry out this investigation.

6. Refernces

[1] John S. H., John D. K., “Comparison of Induction Motor Field Efficiency Evaluation Method”, IEEE Transactions on Industrial Applications, Vol. 34, No. 1, Jan/Feb 1998.

[2] Bureau of Energy Efficiency (BEE), Energy Efficiency in Electrical Utilities: Electric Motors, Available at: http://emtindia. com/BEE-Exam/GuideBooks/book3.pdf .

[3] Bureau of Energy Efficiency (BEE), Energy Performance Assessment for Equipment & Utility Systems: Electric Motors and Variables Speed Drives, Available at: http://emtindia. com/BEE-Exam/GuideBooks/book4.pdf

[4] Bureau of Energy Efficiency (BEE), General Aspect of Energy Management and Energy Audit: Financial Management, Available at: http://emt-india.com/BEE-Exam/ GuideBooks/book1.pdf.Gajendra Singh,N K Sharma, P Tiwari, Pankaj Mishra, “Energy Efficient Industrial Motors”, International Journal of Engineering Science and Technology, 2010, Vol. 2(12), 7904-7913.

[5] Mandeep Verma and Jatin Gupta “Efficiency of rewound Induction Motors in a Textile Plant: An Analysis”, International Journal of Electronics Engg, 3 (2), 2011, pp. 185-187.

[6] Neena Malhotra, Shivani Sehgal, “Efficiency of Rewound Induction Motor in Sugar Mill”, International Journal of Computer Applications, Oct 2012 Volume 55– No.5.

[7] .Austin Bonnett, Brain Gibbon, "The Results Are In: Motor Repai's Impact On Efficiency" White Paper, Reliable Solutions Today, Electrical Apparatus Service Association, 2002.

[8] HM Mzungu, P Barendse, MA Khan and M Manyage, " Determination of effects on Induction Motor Efficiency",time etable.cput.ac., 12 Feb, 2005.