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Performace Evaluation & Life Cycle Costs In Rewound Induction Motors Used In Spinning Units

Ramandip Singh, Dr. S.K.Bath, Varinder Goyal
Research Scholar, Department of Electrical Engineering, P.T.U G.Z.S.Campus Bathinda
H.O.D Department of Electrical Engg. PTUGZS Campus, Bathinda
A.P, Department of Electrical Engg. G.T.B.K.I.E.T CHHAPIANWALI, MALOUT

Abstract: Induction motors being the major energy consumer in the plant offer opportunities of energy saving. In the spinning unit many induction motors are in-house rewound. This paper reports the analysis done on the rewound induction motors to determine its efficiency and life cycle cost comparison. Practical comparisons between rewound motors and the new motors are shown.

Keywords: Rewound induction motor, energy loss, efficiency, life cycle cost, spinning unit.

I. INTRODUCTION

The electrical motors consume large amount of electrical energy. Nearly 80-85% of the load in a spinning unit is on account of induction motors [1]. In these industries a common prevalent practice is to repair and rewind a faulty motor, instead of replacing it with a new one. The efficiency of the motor decreases after it is rewound. This short term capital saving method thus may have a huge long term loss.

II. PROBLEM DEFINITION

The rewound induction motors in textile plant under study are to be analysis for different types of losses in order to get their overall efficiency. The efficiencies of all these motors are then to be compared with the rated and actual efficiencies of new motors taking replacement as one of the options. Recommendations for replacement of rewound motors are to be made accordingly.

III. METHOD

Many in-house rewound induction motors are identified in a major textile plant after several visits.
Working condition of each in-house rewound induction motor is examined. All the parameters of the rewound induction motors are identified and recorded through different means. All the parameters are divided into three different types i.e. rated, measured and calculated. Different instruments are used to measure the measurable parameters that lead to determination of its efficiency [2]. The parameters and respective instruments used in this exercise are listed in the Table 1.

Table 1
Parameters and Instruments Used

Parameter	*Instrument*
Speed	Tachometer
Current	Clamp-on-transducer
Voltage	Power analyzer
Input power	Power analyzer
Winding temperature	Resistance temp. detector
Winding resistance	Power analyzer

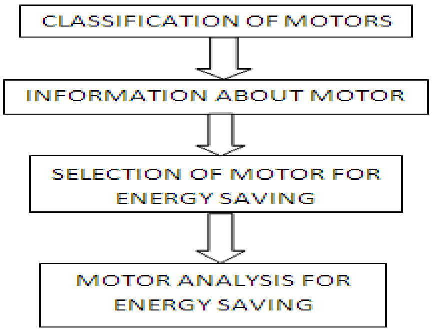

Figure 1: Procedure to Analysis of the Motor

IV. RESULTS AND DISCUSSION

In the plant, the saving in electrical energy is found by analyzing some of the in-house rewound induction motors and looking for alternative options to increase the efficiency of the motors. Sample parameters of one of the in-house rewound induction motor are given in Table 2 after applying the relevant formulae [3, 4].

Table 2 Rated and Measured Parameters of Rewound Induction Motor

Rated Parameters		*Measured Parameters*	
No. of phases, f	3	No-load voltage, $V_{No\text{-}load}$ (V)	410
No. of poles, p	4	No-load current, $I_{No\text{-}load}$ (A)	10
Power, P_{rated} (HP)	20	No-load input power, $P_{No\text{-}load}$ (W)	660
Voltage, V_{rated} (V)	415	Winding Temp. of still motor, T1 (°C)	24
Current, I_{rated} (A)	27	Resistance at room temp., R1 (W)	1.2
Full-load speed, N_{rated} (RPM)	1460	Winding Temp. of no-load motor, (°C)	41
Supply frequency, f (Hz)	50	Winding Temp. of loaded motor(°c),	141
–	–	Full-load voltage (V)	410
–	–	Full-load current, $I_{Full\text{-}load}$ (A)	31
–	–	Full-load i/p power, $P_{Full\text{-}load}$ (W)	17300
–	–	Full-load speed, N2 (RPM)	1475
–	–	No-load speed, N1 (RPM)	1490

Calculated parameters:
synchronous speed
$N_s = (120 \times f) / P = 120 \times 50/4 = 1500$ rpm
Stator resistance at no load
$R = R_0 (1+\alpha t) = 1.05\ \Omega$
Stator resistance at full load
R = R₀ (1+□t)=1.38 □
Stator Cu Loss at no load
Cu loss = $I^2_{No\ Load}$*R=138W
Stator Cu Loss at full load
Cu loss = $I^2_{Full\ Load}$*R=1642 W
Iron Losses
Iron loss= Input Power—Stator Cu losses at No load=555W
No Load Slip (%)
$N_s - N_L / N_S * 100 = 0.67$
FULL Load Slip (%)
$N_s - N_{FL} / N_S * 100 = 1.67$
Full load rotor losses
Rotor losses= $s * p_2$=250W
Stray losses is 1.5% of the full load=260W
Full load output power
Full load output power = $P_{FL} - P_{STRAY} - P_{ROTOR} - P_{C(FL)} = 14582$ W
efficiency
η= (full load output power/ full load input power)*100=84.2%

Determined efficiency of an analyzed in-house rewound induction motor = 84.2 %

Similarly, determined efficiency of an analyzed new motor = 93.25 %

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

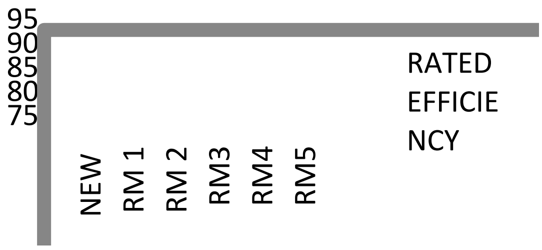

Figure 2: 15HP Motor Analysis

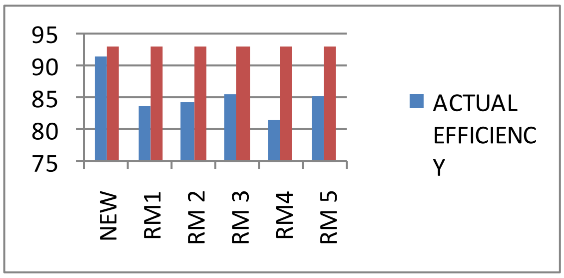

Figure 3: 20HP Motor Analysis

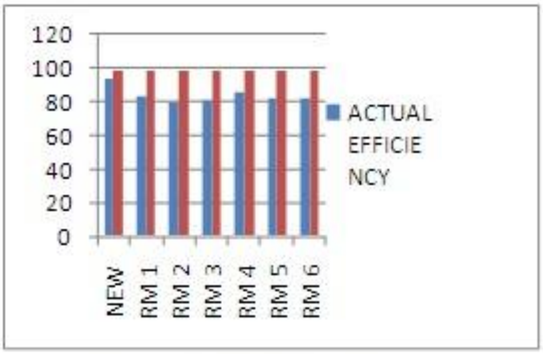

Figure- 4: 50HPMotor Analysis

Figure 2-4 show the efficiencies of new and rewound motors thus rewound motors has low efficiency and more losses. [5].

Life Cycle Cost of Induction Motor

The majority of motors in the field are induction motors. The industry is becoming increasingly concerned about the ability of electric motors to ride through power system disturbances. There may be various reasons for the desire of testing induction motors in the field, such as the consideration of exchanging out of date or worn motors with new, or checking the efficiencies after rewinding.

Life Cycle Cost Comparison of Induction Motor

Indian industry is currently feeling a squeeze on profits due to the rapid rise in power costs. It is no longer practical to consider the monthly power bill as a fixed base cost that cannot be controlled. Power costs have been raising faster than both material and producer good prices. During the 2000's they were increasing at approximately the same rate, and it was generally possible to pass any power increase along to the customer in the form of a price increase. After the energy crunch, power rates increased much faster than the prices for products, so any portion of power posts that could not be passed along came directly out of profits. Since motors account for over 90 percent of power used by industry, they have always had an impact on operating costs. In today's economy, it is more important than ever to keep the cost of motor losses under control. So for Life cycle cost comparison method first of all we have to calculate the rated speed, Efficiencies, Prices of new and rewind motors.

Life-Cycle Cost (LCC)
$LCC=PP + EF \times K W_e$
here LCC= Life Cycle Cost
PP= Motor Purchase price
EF= Evaluation Factor
KW_e= Evaluated loss.

Table-3 Life cycle cost comparison of different motors

Motor type and Rating	Life Cycle Cost of One Year(Rupee)					
	New	R.M 1	R.M 2	R.M 3	R.M 4	R.M 5
15HP	237694	299950	319241	280328	429935	313857
20HP	316342	504720	488797	449082	568183	461160
50HP	555819	1153253	1339678	1539806	992819	1198337

V. CONCLUSION AND FUTURE SCOPE

In spinning unit many induction motors are reused after rebounding. In the present study, performance evaluation and efficiency analysis of rewound motors has been done and the results are compared with those of new motors. Also life cycle costs of new and rewound motors have been evaluated and compared. From the study, it is found that rewound motor consumes 1.5 times to 3 times more energy than new motor Based on the study recommendation has been suggested. Scope of power saving exists in improving the power-factor. A future study on power factor analysis and improvement in thus suggested.

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