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Strategy of Electrical Energy Conservation in a Textile Plant

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Abstract: ***It is always emphasized the necessity of electrical energy saving equipments to reduce the consumption in every industrial sector. The electrical energy audit has been made necessary by all the state government for industry to identify the sites in which electrical energy is not utilized effectively. Therefore, energy savings simply means the reduction in electricity bills. Energy auditing has been done to determine the savings in a textile mill located in Patiala, Punjab. The results of this analysis are reduction of expenses in respect of electrical energy. The payback time period of all re-wound induction motors are likewise identified in order to that the less effective electric motors will be replaced with new ones.***

Keywords: Cost efficiency, Indian textile plant, energy management, energy conservation, and textile industry

1. Introduction

The textile industry is one of the most significant industries in the world. In India, energy saving in the textile industry is also a major issue. Therefore a number of studies have been done in past time, which states that there are a number of opportunities in the textile industries to save electrical energy. The energy audit was carried out on electric motors of distinctive horse power in a textile plant. This analysis also provides a selection of cost savings obtained under numerous circumstances.

1.1 Electrical System in Textile Industry

The electricity system in a textile plant comprises of a small electrical substation which consist of transformer and feeders. Feeders provide the supply in the different sections of textile plant. The Diesel power plant contain diesel generator bearing rating of 1000KVA. When electrical supply is shut off then this diesel power plant provides the supply to the feeders which further supply the electricity. Figure 1 shows the layout of the electrical system and different section of yarn manufacturing unit in a textile plant. In this textile plant lay-out yarn manufacturing unit consists of a raw material store, workshop, compressor unit, chemical lab, blow room section, carding section, finishing, open end (o/e) section, and yarn product store.

Figure 1: Textile Plant Lay-out

2. Problem Formulation

All textile and other industries give the first priority to energy saving. Massive industries already carried out the electrical energy audit to determine the methods by which electrical energy can be conserved. In this research work, an electrical energy audit is executed in a textile plant i.e. Jagdambay Cotspin Limited Yarn Spinning Mills, which is situated in Samana, India. The main problem in this textile plant is more electric bills resulting from unnecessary electric power consumption by electric motors because of losses in electric motors and poor power factor.

3. Methodology

Major electrical energy consuming equipments and machines possessing low power factor is determined after carrying out the primary as well as descriptive audit. And with the energy audit, energy saving sites and devices are determined as well as quantified in some instances.

3.1 Performance of Electric Machines

Electric machines/motors are the most important equipment in textile industry. Numbers of AC drives are connected with these electric motors of various rating motors to drive the spinning, weaving, carding, and blow machines. Entire losses of the rewound as well as squirrel cage induction electric motors in the textile industry can be reduced by increasing the performance of the textile plant by replacing new motors with old rewound or squirrel cage motors and by enhancing the performance of machines.

3.2 Energy Efficient Electric Motors

Energy efficient electric motors minimize electrical energy losses with enhanced design, better components, tight tolerances, and also enhanced production strategies. With appropriate unit installation, energy efficient electric motors may also remain cooler that will help to decrease service heating loads, as well as have greater services aspects, a long time impact life, for a longer time insulating material living, as well as much less vibrations. Sometimes, exchanging a running electric motor with a high quality efficient motor might have a minimal payback time period.

3.3 Adequate Electric Motor Size

Electric motors have to be sized in accordance with procedure needs. In many applications oversized electric motors may be used, set up like a safety factor to control overload. So, by reducing the occurrence of overloading and also considering that many electric motors may run around 15% above their capacities for short durations. Bigger electric motors may replace with smaller sized types offering cost savings.

3.4 Power Factor Correction

Power factor is the ratio of operating power to apparent electrical power. It calculates exactly how efficiently electric power has been utilized. A very high power factor indicates effective employment of electrical power, even while a small power factor indicates very poor usage of electrical energy. The power factor could be corrected by setting up capacitors in the AC circuit to decrease the magnitude of reactive power in the system.

4. Results

After the analysis of squirrel cage 10 HP & 15 HP induction motors as well as re-wound 25 HP, 30 HP & 50 HP & 75 HP induction motors, a proposal is made to preserve the electrical energy, in which actual efficiency of each motor is compared with the rated efficiency & pay-back period of each motor is determined with the help of rated, measured and calculated parameter of the above mentioned motors. Bar graphs in figures 2 to 7 shows the comparison between rated and actual efficiency of different power ratings new induction motor and re-wound induction motors. Bar graphs also show the payback period of each induction motor. So with analysis of graphs shown below in figure 2 to 7, the motors can be easily identified which is more efficient or motors that needs repair and maintenance to improve their performance and also with the analysis of these graphs, decisions are made about replacement of old motor with new motors to save electrical energy.

As a result the bar graphs show the comparison between actual and rated efficiency as well as pay-back period of each induction motor to determine the performance of induction motors. To determine the payback period, for the calculation of the money spent on the power consumed by losses in induction motors the price of one unit (KWH) is Rs. 8 imagined.

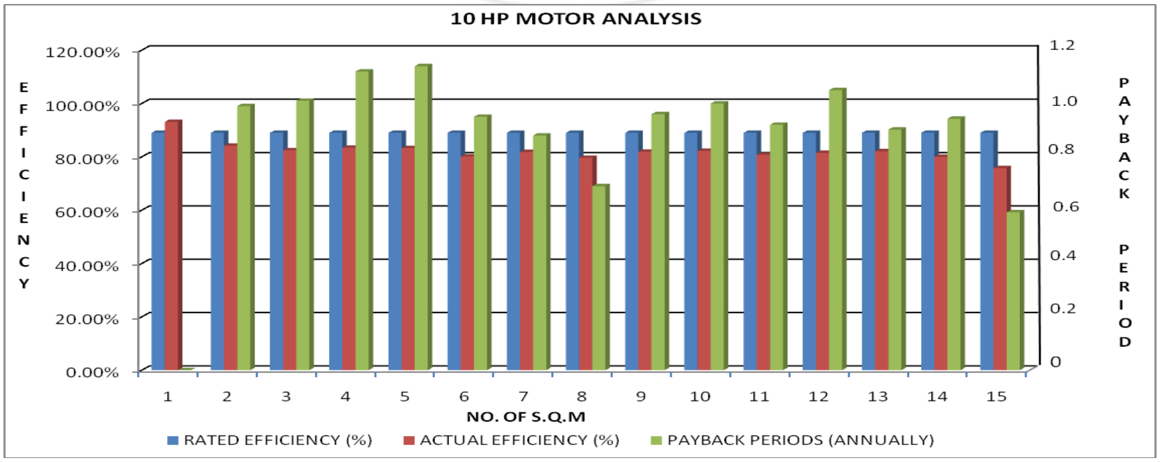

Figure 2: Analysis of 10 HP Motors

Table 1: Parameters of 10 HP Motors

Motor Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rated efficiency (%)	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89
Actual efficiency (%)	93.0	84.1	82.4	83.4	83.2	80.1	81.8	79.6	81.9	82.2	80.7	81.4	82.1	80.0	75.7
Payback period (Annually)	0	0.9	1.0	1.1	1.14	0.95	0.88	0.69	0.96	1	0.92	1.05	0.90	0.94	0.59

Figure 2 shows the bar graph of rated efficiency & actual efficiency of fifteen 10 HP squirrel cage induction motor. Where motor number 1 is the new induction motor and 2 to 15 number motors are old induction motors. From graph it can be concluded that new induction motor is having higher efficiency than old induction motor. First comparison is carried out between rated efficiency and actual efficiency of new motor (motor no. 1) and then a comparison between new motor and older motors (motors no. 2 to 15) is done. Comparison of old motors also shows its payback period of motor No. 5 have highest pay- back period 1.14 years (14 months) and motor No. 15 have a lowest payback period i.e. 0.592 years (7 months). So, the payback period of old squirrel cage 10 HP induction motors vary between 7 months to 14 months as determined from the graph. The table 1 indicates the value of actual efficiency, rated efficiency and payback period.

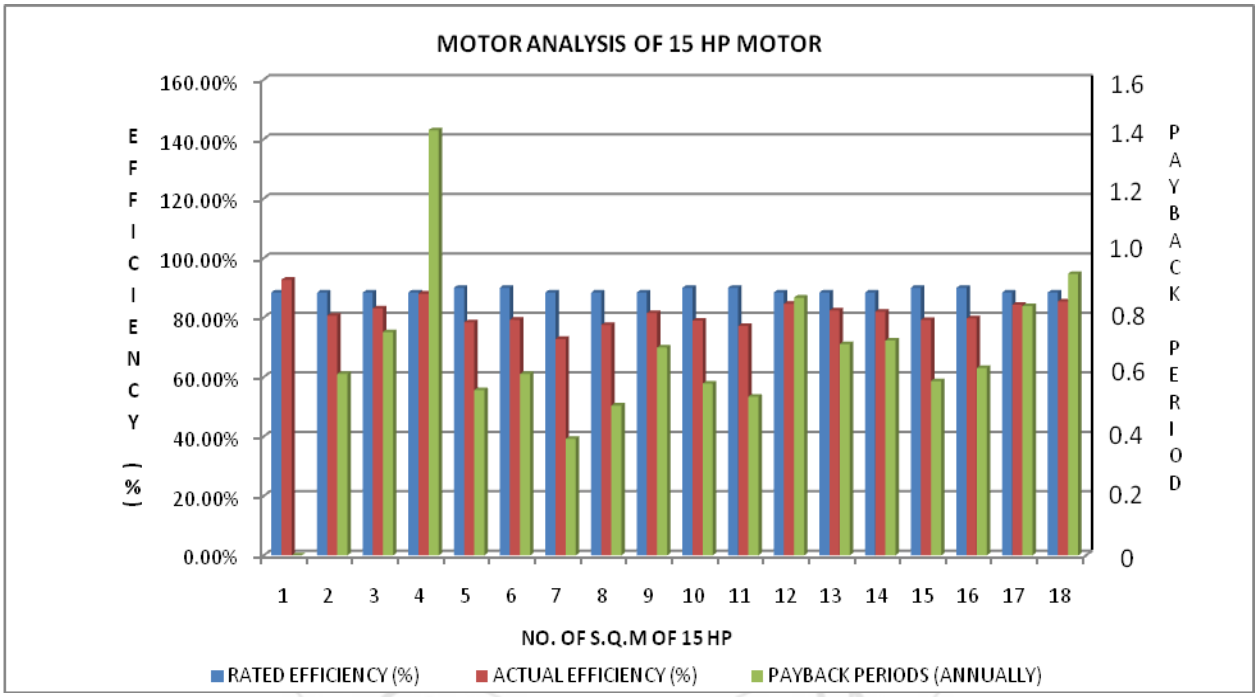

Figure 3: Analyses of 15 HP Motors

Table 2: Parameters of 15 HP Motors

Motor Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Rated efficiency (%)	88.4	88.4	88.4	88.4	90	90	88.4	88.4	88.4	90	90	88.4	88.4	88.4	90	90	88.4	88.4
Actual efficiency (%)	92.7	80.6	83	88	78.3	79.2	72.7	77.8	81.5	78.9	77.2	84.6	82.4	81.9	79.2	79.7	84.3	85.4
Payback period (Annually)	0	0.61	0.75	1.43	0.55	0.61	0.39	0.50	0.69	0.57	0.53	0.86	0.71	0.72	0.58	0.63	0.83	0.94

Figure 3 shows the bar graph of rated efficiency & actual efficiency of eighteen 15 HP squirrel cage induction motor. Where motor No. 1 is the new induction motor and 2 to 18 number motors are old induction motors. It is clear that new induction motor having higher efficiency as compared to the old induction motor. First comparison is carried out between rated efficiency and actual efficiency of new motor (motor no. 1) and then a comparison between new motor and older motors (motors nos. 2 to 18) is done. Every comparison of old motors also shows its payback period of motor No. 4 have maximum pay- back period 1.43 years (17 months) and motor No. 7 have a lowest payback period i.e. 0.392 years (5 months). So, the payback period of old squirrel cage 15 HP induction motors varies between 5 months to 17 months as determined from the graph. The table No. 2 indicates the value of actual efficiency, rated efficiency and payback period.

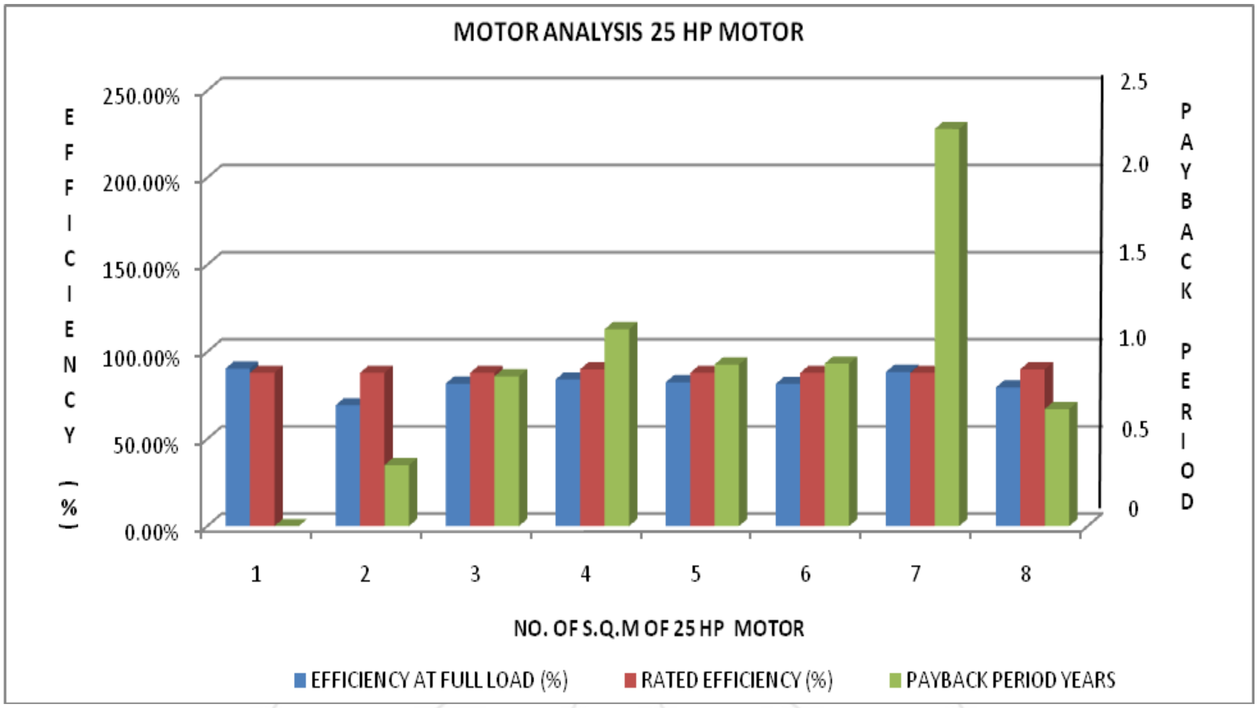

Figure 4: Analyses of 25 HP Motors

Table 3: Parameters of 25 HP Motors

Motor Specification	1	2	3	4	5	6	7	8
Rated efficiency (%)	88	88	88	90	88	88	88	90
Actual efficiency (%)	90.4	69.3	81.8	84.2	82.6	81.6	88.4	79.6
Payback period (Annually)	0	0.35	0.86	1.13	0.92	0.93	2.28	0.67

Figure 4 shows the bar graph of rated efficiency & actual efficiency of eight 25 HP re-wound induction motor. Where motor No. 1 is the new induction motor and 2 to 7 number motors are old induction motors. From the graph it can be determined that new induction motor having higher efficiency as compared to old induction motor. Here 1st comparison is carried out between rated efficiency and actual efficiency of new motor (motor no. 1) then a comparison between new motor and older motors (motors nos. 2 to 8) is done. Every comparison of old motors also shows its payback period of motor No. 7 have maximum pay- back time period 2.28 years (27 months) and motor No. 2 have a smaller payback period i.e. 0.35 years (4 months). So, the payback time period of old re-wound 25 HP induction motors varies between 4 months to 27 months as identified from the graph. The table No. 3 indicates the value of actual efficiency, rated efficiency and payback period**.**

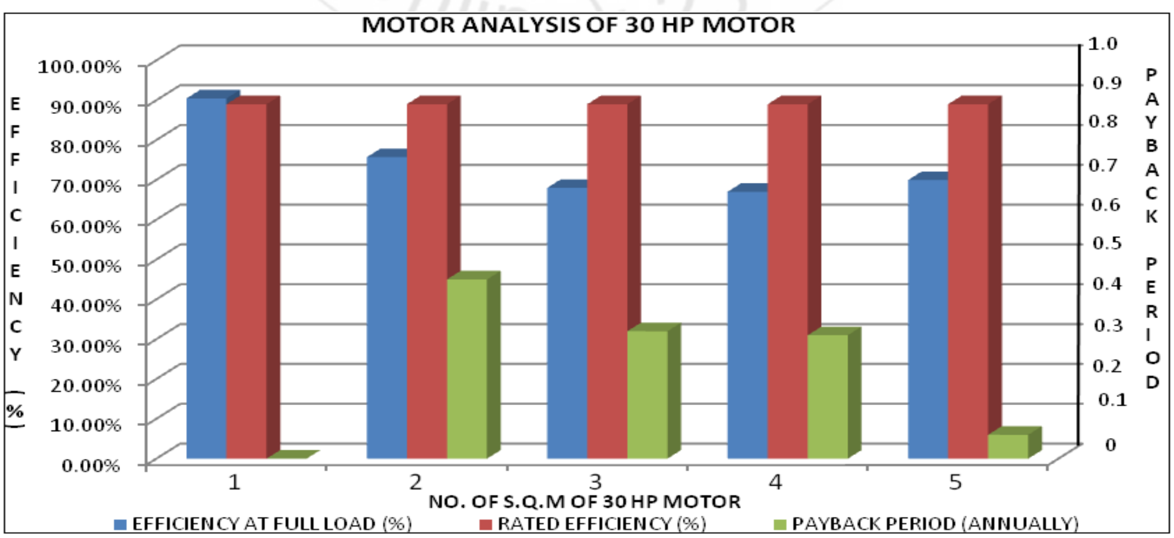

Figure 5: Analyses of 30 HP Motors

Table 4: Parameters of 30 HP Motors

Motor Specification	1	2	3	4	5
Rated efficiency (%)	89	89	89	89	89
Actual efficiency (%)	90.4	75.7	67.9	67.0	69.9
Payback period (Annually)	0	0.45	0.32	0.31	0.06

Figure 5 shows the bar graph of rated efficiency & actual efficiency of five 30 HP re-wound induction motor. Where motor No. 1 is the new induction motor and 2 to 5 number motors are old induction motors. With the help of graph it can be easily identify that new induction motor possessing higher efficiency rather than the old induction motor. Within this initial comparison is carried out between rated efficiency and actual efficiency of new motor (motor no. 1) then a comparison between new motor and older motors (motors nos. 2 to 5) is done. Comparison of old and new motors also shows its payback period such that motor No. 2 have maximum payback time period 0.45 years (5 months) and motor No. 6 has a smaller payback period i.e. 0.06 years (0.72 months). So the payback time period of old re-wound 30 HP induction motors varies between 0.72 months to 5 months as identified from the graph. The table 4 indicates the value of actual efficiency, rated efficiency and payback period.

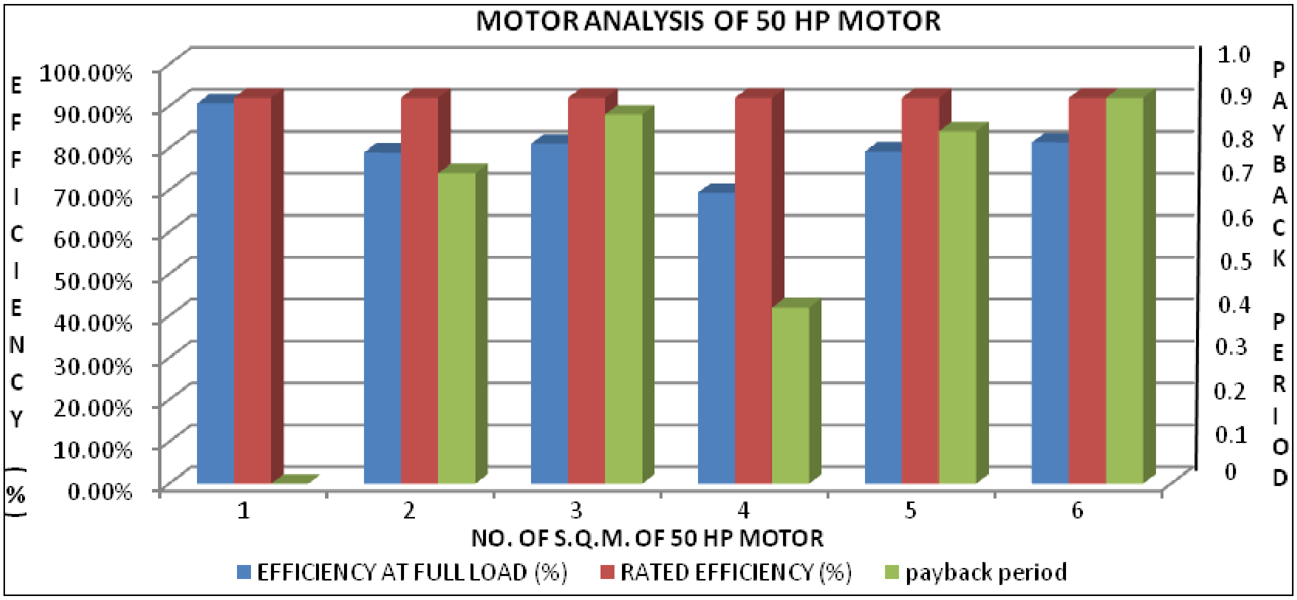

Figure 6: Analyses of 50 HP Motors

Table 5: Parameters of 50 HP Motors

Motor Specification	1	2	3	4	5	6
Rated efficiency (%)	92	92	92	92	92	92
Actual efficiency (%)	90.6	78.9	81.0	69.3	79.1	81.3
Payback period (Annually)	0	0.74	0.88	0.42	0.84	0.92

Figure 6 shows the bar graph of rated efficiency & actual efficiency of six 50 HP re-wound induction motor. Where motor No. 1 is the new induction motor and 2 to 6 number motors are old induction motors. With the analysis it can be easily identify that new induction motor possessing higher efficiency rather than the old induction motor. Within this group initial comparison is carried out between rated efficiency and actual efficiency of new motor (motor no. 1) then a comparison between new motor and older motors (motors nos. 2 to 6) is done. Comparison of old and new motors shows its payback period such that motor No. 6 has maximum pay- back time period 0.92 years (11 months) and motor No. 4 has a smaller payback period i.e. 0.42 years (5 months). So, the payback time period of old re-wound 50 HP induction motors varies between 5 months to 11 months as observed from the graph. The table 5 indicates the value of actual efficiency, rated efficiency and payback period.

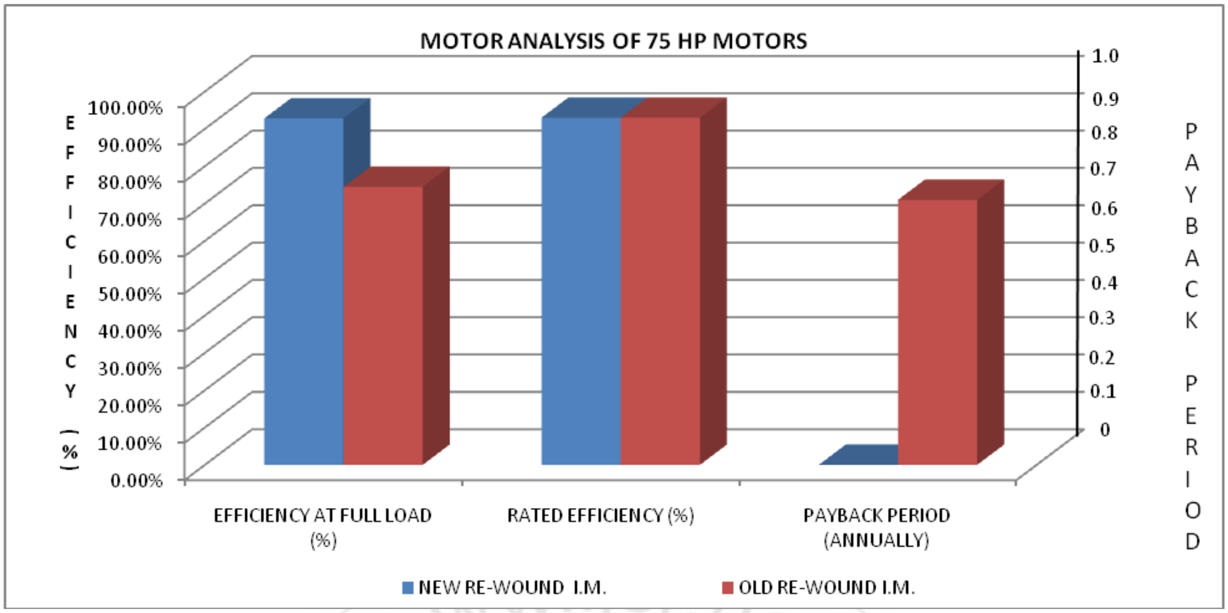

Figure 7: Analyses of 75 HP Motors

Table 6: Parameters of 75 HP motors

Motor Specification	1	2
Rated efficiency (%)	93	93
Actual efficiency (%)	92.82	74.46
Payback period (Annually)	0	0.71

Figure 7 shows the rated efficiency & actual efficiency of two 75 HP re-wound induction motor. New motor and old motor can easily noticed with their colors specification. The 1st comparison is carried out between the actual efficiency of new induction motor and old induction motor. With the help of 1st comparison, it is determined that new motor have better efficiency as compared to the old motor. Whereas 2nd comparison, it can be observed that the comparison is made between rated efficiency of new and older induction motor that is similar for both motors. In the 3rd comparison, payback time period of new and older induction motor is identified. From third comparison it is determined that the old induction motor possess pay-back time period of 0.71 years (8 months). So the new induction motor is more efficient and possessing better overall performance. The Table 6 indicates the value of actual efficiency, rated efficiency and payback period.

As per the analysis carried out for the in-house re-wound induction motors, it is suggested to exchange most of these old re-wound induction motors with new motors. It is also determined that larger motor power rating, the smaller will be the payback period.

5. Conclusion

There is a need to conserve the electrical energy to fulfill the demand from customers. The study of textile plant find out the sites in which electrical energy can be preserved by replacing induction motors with more efficient machines as well as with power factor improvement. After carrying out a throughout study on the induction motors for its proficiency, it is observed that payback period can be reduced with the replacement of old induction motors with new ones.

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