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Performance Management: Life Cycle Management of Electrical Motors for Sustainable Production in Industries

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Abstract

For any given industry, be at any part of the world, it is very important to run its business always at profit by effectively practicing the life cycle management of its assets especially electrical motors by which the electrical power consumption takes place in major part. It is obvious that no industry is running only for charity but to ensure reasonable returns. It is necessary to support the management to increase profits in terms of sustainable production, energy conservation, trouble free running of motors and asset optimization etc., Industry consists of several machines and materials, and of course, men, methods and money to run their process. All machines are classified into two major categories viz., stationary equipment and rotating machines. Further rotating machines are branched into two as one is drive like motor, turbine, etc., and another one is driven end like pump, blower etc., As we know, the energy can be neither created nor destroyed. But it can be changed from one form to another form. In this context, it is a question that do we have standard maintenance and test procedures to obtain energy savings? Do we provide proper operation and maintenance training to the employees in industries? Do we identify the losses from where they occur and their severity? How to reduce the losses and maximize the energy efficiency of motors?

1. Introduction

Business sustainability needs manufacturers to utilize each and every nook and corner where they find possibility of energy saving in this competitive world. Electrical power demand is increasing day by day in India due to the growing industrialization. The final electrical energy consumption is expressed as kWh. The Indian industrial sector is a major energy user, accounting for 48% of the commercial energy consumption. In

industries, motors, transformers, Heating Ventilating Air conditioning (HVAC) systems, boilers etc., are the major power consumers. On the part of agriculture, in the past two decades, there has been a proliferation of groundwater irrigation in India and, therefore, large penetration of pump sets. Estimates put the Fig. of diesel pump sets in India at 6.5 million. To this, another 11 million pumps with electric motor can be added. Of which motors with different types and different ratings are widely used invariably for all process applications.

It is the area of concern that because of lack of awareness about proper operation and maintenance of motors, energy consumed by industry in India is used inefficiently.

2. Paper's Aims and Objectives

In this paper, it is an attempt to indicate crisply what shall be the basic standard maintenance and test procedures of motors? What is the minimum training to be given to the employees on electrical motors maintenance? What are the losses occur due to improper motor maintenance? How best we can achieve energy efficiency by doing which activities?

3. Review on Electricity Consumption of Motors in Industries in India

In industry they run machines, pumps, fans, conveyors and more with electric motors as their prime movers. Out of total electricity consumption in an industry approximately 40 to 50% of energy consumed only by electric motors.

Ref to Figure1, In India, of the total electricity sales in 2011-12, industry sector accounted for the largest share (44.84%), followed by domestic (22.01%), agriculture (17.30%) and commercial sector (8.97%). commercial sector (8.97%).

Ref to Figure2, Globally electricity demand for motor systems is 60% from industry sector. Rising energy prices create higher demand for reduced operating costs with savings from energy efficiency.

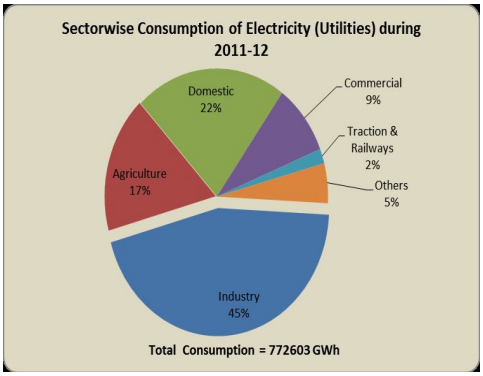

Fig. 1: Sector wise electricity consumption in India during 2011-12

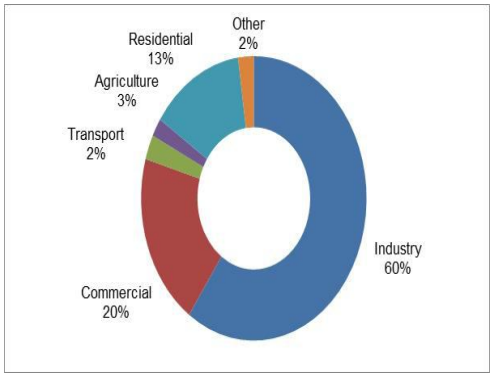

Fig. 2: Global electricity demand for motor systems

4. Operational Challenges of Today

1. To maximize motors reliability
2. To maximize motors availability
3. To ensure ZERO unplanned downtime.
4. To effectively run the motors to their rated capacity
5. To extend the working life of motors

5. Efficiency of Electric Motors

Motors convert electrical energy to mechanical energy to drive the given load.

During this electromechanical energy conversion, energy is getting wasted as indicated in the Fig. 3.

The efficiency of a motor can be defined as "the ratio of a motor's shaft power output to its electrical power input."

The efficiency of a motor is determined by taking into the account of losses as shown in the Fig. 4.

6. Goals of Performance Management

1. To minimize energy cost
2. To minimize waste
3. To maximize output
4. To achieve lower production unit cost
5. To make employee involvement
6. To lower total cost of goods sold
7. To reduce maintenance cost
8. To get better process stability

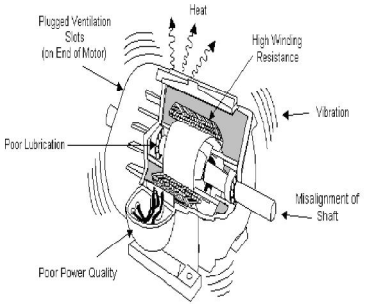

Fig. 3: Various causes for Losses to Occur through Motors.

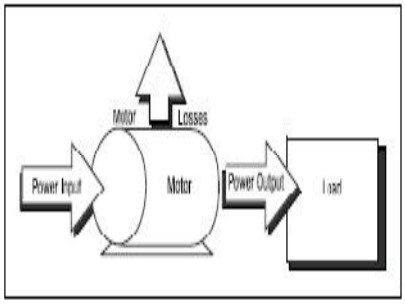

Fig. 4: Depiction of Motor Losses

7. Key Performance Indicators (KPI)

1. Mean Time Between Failures (MTBF) / Mean Time Between Maintenance (MTBM)

2. Cost of Repairs, Average Repair Cost
3. Maintenance Cost
4. Quantified Lost Production Opportunity (LPO)

8. Ideal Features of Motors

Induction machines are the most widely used among all electric motors. The following are the salient features:

1. Easier and rugged construction
2. Good efficiency
3. Stable operation under load
4. Controllable torque-speed curve
5. Wide range of sizes from few Watts to several MW

9. Performance Management

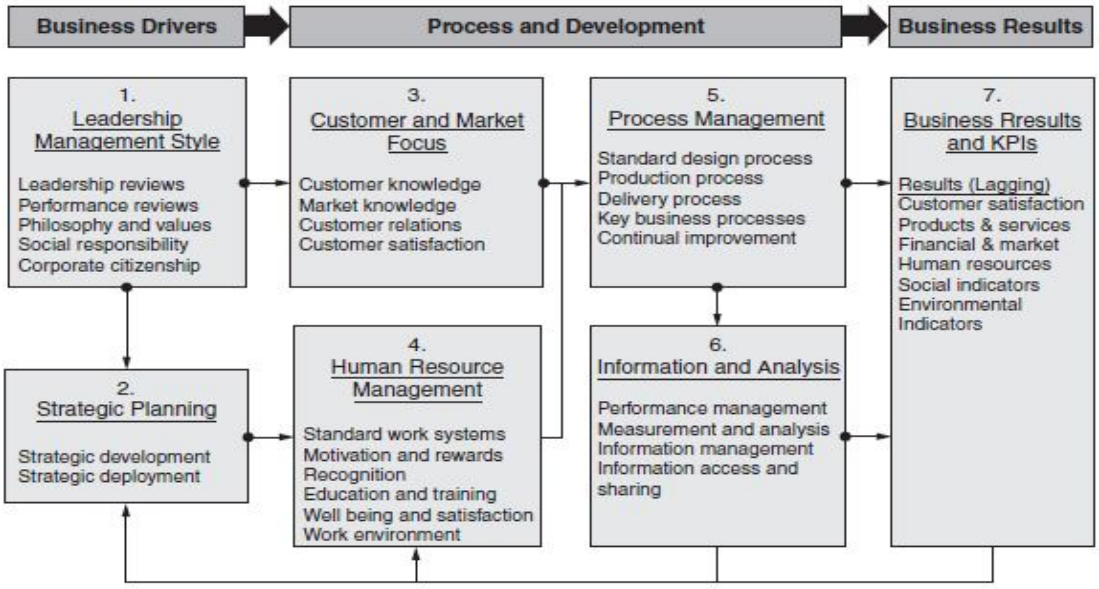

Fig. 5: Primary Elements of Performance.

The Performance Management is the cost effective condition monitoring. In this the electrical motors are detected for the premature conditions that may lead to a chance for a failure and also to predict the probable time when such a failure is likely to occur.

The life cycle management is nothing but to help the motors that is to maintain them in routine manner to run without any trouble throughout its working duration.

The advantages of performance management are as below:

1. Minimizes the unexpected interruptions
2. To eliminate / correct the unsafe working conditions

3. To improve product / service quality
4. It provides real time monitoring of the condition of motors
5. To plan and execute the maintenance well in advance to avoid unnecessary breakdowns.

Ref to Fig. 6. It is needless to state that there is expenditure in the name of preventive maintenance cost, which is certainly necessary to upkeep the performance of motors.

In addition to the above, the following are the additional benefits of performance management:

1) The employees own their machines and take further responsibility
2) Helps to implement JIT to reduce inventories
3) Utilize the state-of-the art control and instrumentation systems
4) Use computers and software in maintenance management.

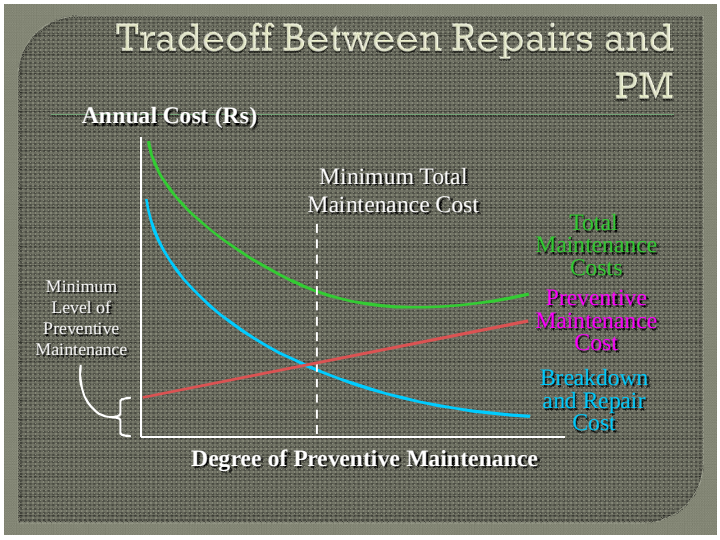

Fig. 6: Minimum Total Maintenance Break even Cost.

10.10. Types of Losses Occur at Motors

1. Rotor loss
2. Fixed losses (iron losses)
3. Friction and winding
4. Stator loss
5. Stray load losses

11.Factors that Influence Motor Efficiency

1. Due to ageing motors become less efficient.
2. As rated capacity rises, motor efficiency also increases.
3. Normally high speed motors are more efficient.

4. Depends upon the type efficiency varies. For example, squirrel cage motors are normally more efficient than slip-ring motors

12.Best Practices for Efficient Operation

1. Use efficient motors instead of local makes.
2. Switch off the motors which run unnecessarily.
3. Avoid frequent starting and stopping of motors to reduce the wear and tear of internal parts and also to reduce the frequent maintenance.
4. Reduce under-loading and also avoid over-sized motors.
5. The associated mechanical system efficiency to be improved to reduce the number of hours the motor run.
6. We shall not run the motors beyond the rated speed.
7. Maintenance to be planned well in advance.
8. Operate in star mode (from delta mode)
9. Allocate manpower reasonably.
10. MTBF/MTBM statistics to be maintained.
11. Where ever possible VVVF drives can be used.

13.Best Practices for Maintenance

The motors are to be maintained according tomaintenance check list as mentioned below:

13.1 Maintenance Check list- General

1. Motors power supply rating is suitable for the application
2. Whether all motors are ISI certified?
3. Number of motors available
4. Number of motors in operation
5. Number of motors in stand by
6. Electrical power supply voltage used
7. Ensure supply wiring and terminal box are properly sized and installed

13.2 Visual Inspection

1. Evidence of damage caused by dirt, loose parts, foreign objects
2. Evidence of oil leaking, water piping leaking through connections
3. Verification that air ventilation ports are not blocked
4. Unusual noises
5. leaking oil seals
6. abnormal/high vibration
7. Low oil level in oil gauges
8. Evidence of degrading of foundation, bed bolts, anchor bolts
9. Evidence of improper/loose earth connection

13.3 Routine maintenance

1. Clean motor surfaces and ventilation openings periodically
2. Properly lubricate moving parts
3. Keep motor couplings properly aligned
4. Properly align and tension belts and pulleys when they are installed
5. Ensure that alignment and tension stay within tolerances
6. Check for proper supply voltages
7. Avoid painting motor housings
8. Provide adequate ventilation

13.4 Temperature Monitoring

1. Note, Measure and record bearing temperature
2. Record stator temperature
3. Check whether the temperature sensors are located properly
4. Note the ambient temperature reading

13.5 Running Current

1. Measure three phase currents and frequency
2. Verify the currents are balanced
3. Confirm that measured currents not exceeding the current mentioned in name plate

13.6 Good Record Keeping

Poor information systems are the main cause of lack of electricity and resource consumption data. The reason for poor monitoring is often that energy is considered as a fixed cost and therefore not actively monitored or managed.

1. Maintain an up-to-date motor inventory
2. Keep maintenance logs
3. Consider a computerized maintenance program that incorporates inventories and logs.

14.Training Objectives

1. To explain about the advantages of electric motors.
2. To consider selection criteria of electric motors.
3. To explain the constructional features of electric motors.
4. To distinguish the types of electric motors.
5. To know about the uses of different types of motor enclosures.
6. To provide standard maintenance procedures for electric motors.
7. To insist the importance and maintenance of electrical protection and controls.

15. Conclusion

The preventive maintenance program is to be practiced by all industries invariably even small, medium or large by type, that is to have maintenance check sheet to ensure that the motors are well maintained as per the standard procedures and technical requirements and to use history card to update the periodicity of up keeping.

Limited internal knowledge and expertise is also a common problem. A minimum technical knowledge of motor, energy and safety is required to identify, investigate and implement work procedures to improve resource and energy efficiency.

It is the part of management to provide adequate training to help their internal employees to ascertain that the electrical motors will run efficiently to reduce energy consumption drastically. Thereby the industry will not only save tremendous energy cost but also upkeep the life cycle management of motors, which will further optimize the asset allocation and not only raise the profits to the industry, but also help the nation to minimize the consumption of natural resources.

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