IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

National Level Conference – AITCON 2K25

Adarsh Institute of Technology & Research Centre, Vita, Maharashtra

Vol. 12, Special Issue 1, March 2025

Condition Based Monitoring of Rotating Electrical Equipments

Mr. Kulkarni O.G.[1], Miss. Sankpal A.V.[2]

Associate Professor, Dept. of Electronics and Telecommunication Engineering, Shivaji Polytechnic Atpadi, Maharashtra, India[1]

Assistant Professor, Dept. of Electrical Engineering, Shivaji Polytechnic Atpadi, Maharashtra, India[2]

Abstract: Rotating machines are very essential at growing industries as well as in power stations.From compressor to pumps to motors to generators, plant profitability revolves around equipment productivity. Conditioning monitoring is crucial for ensuring reliability and efficiency. Monitoring these systems tracking parameters such as temperature, vibration current and more provides valuable insights into machine health and performance. The monitoring of a fault can be divided into four levels 1: Fault detection 2: Fault localization 3: Fault assessment 4: Fault consequences.

Keywords: Maintenance, Rotating machines, Vibration Analysis, Condition Monitoring, Fault.

I. INTRODUCTION

Electrical maintenance is a process that involves the routine inspection, testing, repair and replacement of electrical systems and equipment to ensure their safe and efficient operation. Maintenance work is carried out to prevent the damage, obstacles and breakdown of the machine. Maintenance prevents ill effects in future.
Different categories of maintenance are

i) Routine Maintenance
ii) Preventive maintenance
iii) Breakdown maintenance
iv) Predictive maintenance (Conditioning monitoring).

Method i) it is the daily work to check electrical and mechanical conditions. In Method ii) due care is taken by preparing a planned schedule of maintenance which can be called a preventive maintenance schedule, for different machines different maintenance charts are prepared. Method iii) as the title suggests this maintenance is essential in case of failure of machine. Method iv) Condition monitoring is the process of monitoring a parameter of condition in machinery in order to identify a significant change which is developing fault. It is a major component of predictive maintenance. By observing the state of the system known as “conditioning Monitoring” this maintenance is done.

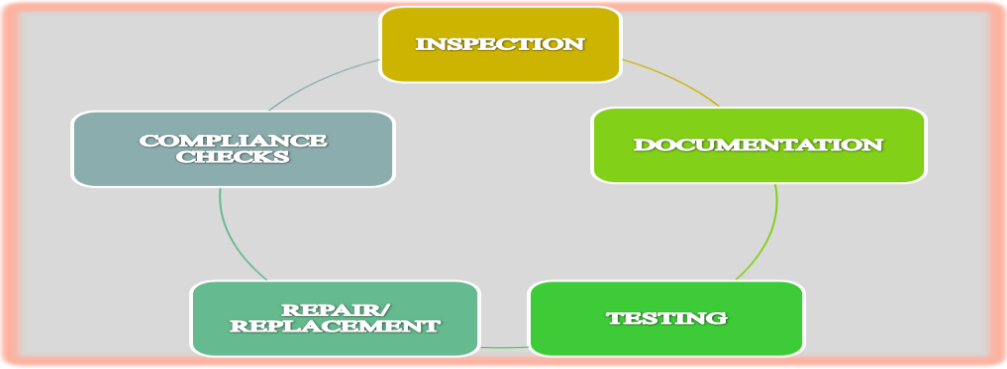

Fig 1. Electrical Maintenance Overview

II. TYPES OF FAULTS IN ROTATING ELECTRICAL EQUIPMENT

Mechanical Faults: Bearing failure, bent Shape, unbalance, misalignment.
Electrical Faults: Damaged insulation, connections opening, winding issues.
Environmental Faults: Temperature and humidity effects, as well as external vibrations.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

National Level Conference – AITCON 2K25

Adarsh Institute of Technology & Research Centre, Vita, Maharashtra

Vol. 12, Special Issue 1, March 2025

III. CONDITIONING MONITORING TECHNIQUES FOR ROTATING MACHINES

Monitoring the performance of rotating machines using condition monitoring techniques is essential for ensuring optimal operation, minimizing downtime, and preventing unexpected failures. Here is some common condition monitoring techniques used for monitoring rotating equipment.

1. Vibration analysis

Potential faults in rotating machinery are often first picked up by vibration measurements.Vibration monitoring is therefore one of the most effective ways to detect developing faults.These includes imbalance,bearing wear,
misalignment and other mechanical faults such as worn or bent shafts.As this happens ,levels of vibration increase. The use of vibration sensors,therefore detects the changes and alerts plant operators when this becomes excessive.

1.1 Vibration Characteristics

Amplitude- Helps in detecting the severity of the fault condition or defect
Frequency- Helps in indicating the causes of the defect
Phase- Helps in determining the cause of the defect

Vibration amplitude can be measured in terms of displacement, velocity, acceleration .Displacement is measured peak to peak and usually in miles or microns. Velocity can be measured in peak or RMS and usually in inch/ sec or mm/sec. Acceleration is expressed in peak and usually measured in g's. Phase indicates how a machine is moving to a reference of its part. The relationship of the movement of part of a machine to a reference -for example the position of both ends of the shaft as it rotates. This indicates the relationship of the movement between one or more points on a machine.

1.2 Vibration measurement instrumentation

The types of measurement devices used include accelerometers, velocity and displacement transducers.

FFT Analyser: FFT is the most commonly used tool for vibration analysis. As we measure the real time data in which the plot is against amplitude Vs. time ,FFT converts this into Frequency Vs. Amplitude. Amplitude shows the severity of the fault and frequency shows the origin of the fault.

2. IR -Infrared condition monitoring

Another method of machine condition monitoring is IR (or thermography)- where infrared/thermographic cameras are used to detect abnormal heat patterns being emitting from an object which can indicate faults or inefficiencies .We typically use IR to monitor electrical and mechanical conditions of motors , control panels and abnormal friction of bearings, lubrication issues ,or insulation faults .Regular thermographic inspection can help to detect early signs of impending failures and allow for timely corrective action.

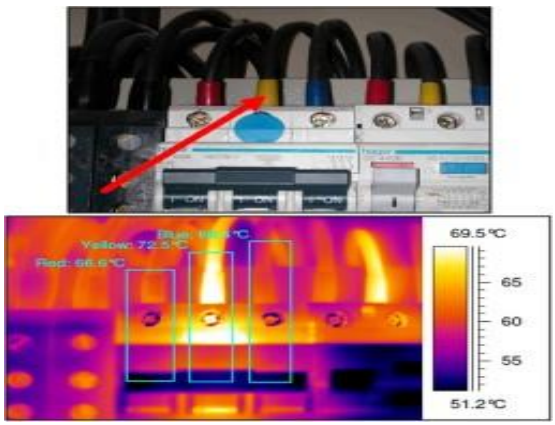

Fig 2. Thermography image

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

National Level Conference – AITCON 2K25

Adarsh Institute of Technology & Research Centre, Vita, Maharashtra

Vol. 12, Special Issue 1, March 2025

Thermography used to recognize equipment hot spots.This task is typically carried out using temperature sensing instruments like thermocouple sensors or thermometers. Limitations of this analysis is that this kind of instrument can give maintenance personnel only with temperature readings on certain spots but not the overall electrical system.
Thermography inspection generally uses infrared instrumentation to scan and create a temperature profile of intended targets.

In a typical manufacturing plant, Infrared thermography inspections were done on electrical systems such as electrical switchboards, high-voltage distribution equipment motors, corresponding controllers, transformers and other control panels.

2.1 Infrared Thermography Testing can be Done on

- Detecting loose or corroded electrical connections
- Detecting electrical unbalance and overloads
- Inspecting bearings and Electrical motors
- Inspecting steam systems IR Imaging helps better to recognise and report suspect elements
- Enable the repair to be done right the first time.
- High resistance connections
- Hot spots

2.2 What Are the Benefits of Thermography Inspection?

The National Fire Protection Association (NFPA) estimates that ten percent of the fires occurring in manufacturing properties are related to electrical system failures, such as failure of electrical insulation, terminals, and related components. Additionally, failures can cause employees to be exposed to live electrical circuits, making them susceptible to serious injury or death from electrocution. By detecting high-resistance connections and repairing them, the likelihood of a breakdown of the electrical wires and related components should be reduced.

Other advantages to detecting and repairing these faults are the cost savings from energy conservation and lower outage and repair costs. High resistance in circuits causes an increase in current flow. When current flow is increased, the resulting power consumption will increase. Further, high current draw can cause critical electrical circuit components, such as fuses, circuit breakers, and transformers, to fail prematurely. These failures result in higher maintenance and repair costs, and resultant business interruptions.

3. Oil Analysis:

Oil analysis involves testing and analysing the properties and contaminants present in lubricating oils used in rotating equipment. It provides insights into the condition of the equipment, the presence of wear particles, oil degradation, and the presence of contaminants such as water, metal particles, or dirt. By monitoring the oil quality and trend analysis of oil test results, it is possible to detect abnormal wear, lubrication issues, and potential failures in advance.

3.1 Oil analysis sensor technology:

Oil sensors come in many different types. Some measure the oil's dielectric constant, which changes as the oil degrades or becomes contaminated. (A substance's dielectric constant reflects its ability to keep an electric field from forming in it.) Other oil sensors measure optical characteristics and compare them to model conditions to assess the oil's quality (a technique called Fourier transform infrared spectroscopy). Still others use magnetic fields to detect and classify metallic particles in the oil (a sign of wear). And still others again use x-ray emissions to detect the presence of foreign elements.

Oil sensors need to be placed on or near the asset that is being monitored. For this reason, oil analysis sensors are not suited to monitoring assets that are:

- inaccessible (such as underground pumps)
- remote or widely spaced (such as offshore wind turbines)
- situated in hard-to-reach places
- situated in hazardous environments, such as ATEX zones
- situated in harsh conditions, such as hot strip steel mills where extreme temperatures can damage the sensors and the resultant flow of data

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

National Level Conference – AITCON 2K25

Adarsh Institute of Technology & Research Centre, Vita, Maharashtra

Vol. 12, Special Issue 1, March 2025

IV. KEY BENEFITS OF CONDITION MONITORING FOR ROTATING MACHINERY

By carrying out Machine Condition Monitoring, you can:

- Form part of a proactive maintenance program for critical rotating equipment monitoring
- Predict potential problems and plan maintenance in advance, before it's too late
- Increase performance, quality and productivity
- Increase reliability and operational safety of your machinery
- Save energy and decrease fatigue loading on the bearings and other mechanical supports
- Reduce unplanned, costly downtime
- Minimise maintenance costs
- Reduce requirement for emergency parts

V. CHALLENGES IN CONDITION MONITORING

- High Initial Cost
- The massive volume of data generated by sensors can overwhelm operators if not processed effectively.
- Environmental factors

VI. CONCLUSION

From the paper, it can be concluded that, adapting the philosophy of predictive maintenance can be beneficial to all industries and plants. Using predictive maintenance, we can increase the life spans of various machinery and avoid unwanted shutdowns and downtime. Predicting a failure before it occurs can help analyse the root cause of the occurrence of machine fault and can prevent the failure of the machine in question which might in turn cause damage to other machines in the system. Vibration analysis, Infrared Thermography plays a major role in predictive maintenance, defects that are not visible to the naked eye and that seemingly do not show any physical symptoms can be detected by this method, and thus is very important in the topic of plant maintenance.

REFERENCES

[1] "Vibration based condition monitoring of rotating machinery Gautam Senapaty1* and Sathish Rao U.1 1Department of Mechanical and Manufacturing Engineering, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, India.

[2] "Vibration Analysis Of Rotating Machines With Case Studies Sagar Sutar, Vilas Warudkar, Rajendra Sukathankar

[3] "Condition monitoring on rotating electrical machines," IEE Colloquium on Instrumentation of Rotating Electrical Machines, London, UK, 1991, pp. 6/1-6/3. keywords: {Monitoring;Electric machines;Microcomputer applications},

[4]https://wdbgroup.co.uk/blog/the-benefits-of-machine-condition-monitoring-for-rotating machinery/#:~:text=Rotating%20machinery%20is%20often%20critical,a%20developing%20fault%2C%20or%20failure.

[5] W. T. Thomson, "Research and development of online diagnostic monitoring systems for electrical machines," IEE Colloquium on Instrumentation of Rotating Electrical Machines, London, UK, 1991, pp. 5/1-517. keywords: {AC machines;Monitoring;Fault location},

[6] "IEE Colloquium on 'Instrumentation of Rotating Electrical Machines' (Digest No.036)," IEE Colloquium on Instrumentation of Rotating Electrical Machines, London, UK, 1991, pp. 0_1-. keywords: {Monitoring;Electric machines},

[7]https://www.researchgate.net/publication/3478386_Review_of_condition_monitoring_of_rotating_electrical_machines_Electric_Power_Applications_IET_24_215-247

[8] Predictive Maintenance Strategies for Electrical Equipment: A Literature Review Jordan Y. Arpilleda Faculty, Department of Industrial Technology,North Eastern Mindanao State University - Cantilan Campus, Cantilan, Surigao del Sur,Philippines

[9] https://en.wikipedia.org/wiki/Condition_monitoring

[10] https://carelabz.com/electrical-infrared-thermography-inspection-important/

[11] https://www.ruggedmonitoring.com/asset-monitoring/rotating-machines-monitoring-system/