



The Shirpur Education Society's

**R. C. Patel College of Engineering and
Polytechnic, Shirpur**

Department of Mechanical Engineering

NAME OF COURSE: - Emerging Trends in Mech Engg

CODE OF COURSE: - 315363

SEMESTER: - ME-5K (TYME)

**Unit - 4 Recent Trends in Maintenance
14 Marks**

SUBJECT TEACHER

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Unit 4 = Recent Trends in Maintenance

Maintenance =

To keep any machine or system in safe & efficient working condition maintenance has been done. Inspection of all components, servicing, repairing faulty components & replacement of faulty component, if needed, ~~these~~ These are the steps followed in maintenance process.

Types of maintenance =1) Preventive maintenance =

Maintenance has been carried out ~~at~~ ^{at} fixed intervals before breakdown happens. It includes scheduled inspection, cleaning, lubricating, replacement of worn out parts.

Eg. Engine oil replacement of bike at every 3000 km.

2) Corrective2) Predictive maintenance =

In this type of maintenance, continuous monitoring of any sign or symptom of potential failure has been carried out & maintenance of worn out or fail part is carried out. (Replaced or repaired)

Eg - Noise from any part indicates need of servicing.

3) Breakdown maintenance =

In this approach machine runs until it gets failed, after that maintenance is carried out by replacing failed part.

Eg - Repairing a fan when it stops working.

4.1) Autonomous maintenance =

In this maintenance strategy the machine operators role is to clean, lubricate, inspect & tight loose parts, if any. It is a main pillar of Total Productive maintenance (TPM) & it allows to keep

Machine in safe, and efficient working condition.

Main moto of autonomous maintenance is to maintain machines safe, good & efficient working condition, less breakdowns, improved productivity & good life of machine/equipment.

Objectives of autonomous maintenance =

- i) Reduction in m/c breakdowns & failures.
- ii) Improvement in efficiency & reliability of m/c.
- iii) Increment in Overall Equipment Effectiveness (OEE)
- iv) Detection of problems at initial stage
- v) Reduction in maintenance cost & downtime.
- vi) Product quality improvement
- vii) Safe & efficient working environment.

Pillars of TPM (Total Productive Maintenance)

TPM is a maintenance management technique that focus to maximize machine/equipment effectiveness by involvement of all employees in maintaining machines/equipments & improving productivity.

TPM is based on eight pillars, each help to improve machine/equipment performance, product quality & efficiency of workplace.

Eight pillars of TPM :-

- 1) Autonomous maintenance (Jishu Hozen)
- 2) Planned Maintenance
- 3) Quality Maintenance.
- 4) Focused Improvement (Kaizen)
- 5) Early equipment management.
- 6) Training & education.
- 7) Safety, health, & environment (SHE)
- 8) Office TPM

1) Autonomous maintenance (Jishu Hozen)

Autonomous maintenance (Jishu Hozen), is one amongst eight pillars of TPM. In this technique machine operator has to take responsibility for daily care of their machine/equipment instead of dependence on maintenance department.

Operator can perform daily activities like cleaning of m/c/equipment, Inspection, Lubrication, ~~tightening~~ tightening of loose parts, detecting any problem. Main motive is to keep m/c in good & safe working condition, reduce breakdown & improvement in reliability. This technique develops operators' knowledge & sense of ownership towards m/c.

2) Planned maintenance =

In this approach maintenance activities are scheduled when machine/equipment isn't scheduled for production, operation. It aims to reduce unexpected failure of m/c. By proactive approach maintenance cost is also reduced, as parts/components can be fixed before actual failure occurs. It improves reliability of m/c/equipment. Reduce downtime etc.

3) Quality maintenance =

This approach focusing on maintaining m/c such that it can produce very less defective parts, subsequently less repairs required. Identify & eliminates the main root cause behind defective parts.

This technique improves the quality in production, reduces the rejects & rework & gain higher customer satisfaction.

4) Focused improvement (Kobetsu Kaizen)

This technique is adopted continuous improvement approach. Small group of people form to minimise losses & to improve equipment/m/c performance.

Small group consisting of m/c operators, maintenance staff & engineers, they work with each other to find, analyze & eliminate the losses that responsible for reduction in productivity & product quality.

Objectives are

- i) Reduce m/c losses & waste.
- ii) Improved in effectiveness & m/c efficiency.
- iii) Reduction in downtime, rejects & rework.
- iv) Improvement in product quality.
- v) Reduction in m/c cost.

5) Early equipment management =

This approach focused on fault free & smooth implementation during the design, select, install & purchasing of new machine & equipment. The aim is to make m/c ease for operation, maintenance & efficient till their life. This benefits in faster m/c startup, low lifecycle cost, & improved reliability.

6) Training & education =

In this approach the focused ~~is~~ on development of ~~knowledge~~ knowledge, technical skill & problem identification & solving ability of operators & maintenance staff. Proper training is provided to the employees regarding maintenance of equipment efficiently, reduction in error & to improve productivity.

7) Safety, health & environment (SHE)

This approach focused on creation of safe, healthy & eco friendly environment in workplace by reducing unsafe working condition, reduction in pollution & accidents. The motto of SHE is to reduce accidents to zero, zero health hazards & zero environmental damage. It can be achieved by conducting regular safety inspections, by providing

training to operators, by providing safety equipments, identifying & eliminating unsafe conditions, by taking proper pollution control measure etc.

8) Office TPM =

It applies TPM principles to administration & support departments like purchasing, planning, accounts, HR, quality control etc. Its motto is to improve office efficiency by reducing delays, errors & by proper communication channel.

Implementation steps of autonomous maintenance =

1) Cleaning =

- Clean machine by removing foreign particles such as dirt, dust, grease, oil etc.
- While cleaning machine parts identify any defects such as leakages, cracks, wornout parts, loose parts.
- Fixe the identified problem by maintenance.

2) Eliminate sources of contamination & inaccessible areas =

- Identify the causes behind settlement of dirt, dust, grease & oil, fixe the source.
- Modify the machine design to make ease in cleaning & inspection if needed.
- Reduce time requirement for regular maintenance by adopting proper maintenance method.

3) Create cleaning & lubrication standards =

- Create standard operating procedures for cleaning, lubrication & inspection.
- Highlight what to be clean, lubricate, inspect & how many times.
- Maintain consistency in maintenance process.

4) General inspection =

- Provide training to operators time to time for inspection of machine components like belts, chain, gears, bearings, motors, electrical parts etc.
- Identify the problem in its initial phase & take necessary action.

5) Autonomous Inspection & Standardization =

- Operators need to conduct regular inspections to identify any abnormalities using checklists.
- Keep all record of findings & also communicate it with maintenance department.
- Make standard operating procedure for every activity need to be performed like cleaning, inspection, lubricate, any other activity related to m/c.
- Make work methods, inspection schedules standardize to ensure uniformity in maintenance activity & keeping machines in good working conditions.

6) Continuous improvement & Autonomous management =

- Adopt technique like Kaizen (Continuous improvement) to eliminate losses.
- Motivate operators to identify opportunities for improvement, by getting feedback from operator make necessary changes.

Benefits of Autonomous maintenance =

- i) Reduction in breakdowns.
- ii) Increased reliability of machine
- iii) Improvement in productivity.
- iv) Skill improvement of operator
- v) Reduction in maintenance cost
- vi) Improvement in quality production.
- vii) Increased machine life
- viii) Promotes ownership & teamwork.

ix) Improves safety, health & eco friendly working environment.

x) Increased OEE (Overall equipment effectiveness).

4.2) Sustainable maintenance =

Sustainable maintenance is a maintenance approach that ensure equipment, machines, and facilities operates efficiently while minimizing environmental impact & promoting economic & social well being.

It emphasis on extending life of m/c/equipment through ~~well~~ maintenance (Preventive, pro-minimizing waste generation & by ~~the~~ effective use of natural resources.

Objectives of sustainable maintenance =

- 1) Minimum m/c breakdowns.
- 2) Reduction in energy consumption & low green-house gas emissions.
- 3) Increment in life span of m/c.
- 4) Less waste generation & promote reuse, recycle.
- 5) Safe, healthy working environment.
- 6) Reduction in cost for operation & maintenance.
- 7) Increased productivity & reliability.
- 8) Meet sustainable mfg & environmental regulations.

Principles of sustainable maintenance =

- 1) Preventive maintenance = Maintenance on fixed schedule, to minimize unwanted breakdowns & waste.
- 2) Predictive maintenance = By adoption of sensors & processors keep close monitoring on possible machine

machine failures.

- 3) Energy efficiency = Optimization of energy consumption through effective maintenance.
- 4) Resource conservation = Effective use of consumables like water, coolant, raw material, lubricant etc.
- 5) Reduction in waste = Adopt 5-R technique to reduce waste. (SR = Reduce, Reuse, Recycle, Refuse, Repurposed).
- 6) Safety & health = Maintaining machine in safe & healthy working conditions.
- 7) Continuous improvement = By application of various key approaches like Kaizen, Lean manufacturing, TPM to improve maintenance effectiveness.

Sustainable maintenance implementation steps =

1) Assess ongoing maintenance practices =

- Evaluate ongoing maintenance approach, procedures & machine performance.
- Find out frequent m/c breakdowns, sources of ~~waste~~ waste & Loss of energy.
- Analyze operational, maintenance cost & its impacts.
- Create base for future improvements.

2) Set sustainability goals =

Highlight objectives clearly like -

- Reduction in downtime.
- Low energy utilization
- Low waste generation.
- Long machine lifespan
- Improved safety.

- 3) Adopt preventive & predictive maintenance approach =
- Carryout regular cleaning, inspection, lubrication etc.
 - Use sensors, processors, to monitor on performance of machine.
 - Conduct maintenance if found any abnormality.

- 4) Prepare Sustainable maintenance plan =
- Prepare effective plan for maintenance based on m/c utilization.
 - Make budget for maintenance in advance.
 - Clearly define role & responsibility of members in maintenance department.

- 5) Improvement in energy efficiency =
- Maintain equipment to get optimum operating efficiency.
 - Replace worn out, failed component if needed.
 - Find leakage in pneumatic lines, hydraulic system & fix them at ~~end~~ earliest.

- 6) Promote recycling & reduce waste generation =
- Recycle used lubricants, coolants, filters etc..
 - Reuse machine components if possible.
 - Dispose toxic waste safely following guidelines.

- 7) Optimize spare part management =
- Maintain optimum amount of spare parts in inventory.
 - Purchase long life, reliable & eco friendly materials if possible.
 - Do not purchase excess components than optimum level.

- 8) Training & involvement of employees =
- Provide training to operators, maintenance team members on sustainable maintenance practices.

- Create awareness regarding safety & responsibility towards environment.
- Motivate operators to suggest improvements in adopted method through Kaizen.

9) Adopt use of digital technologies =

- Adopt CMMS (Computerized maintenance management system).
- Use sensors, cameras, & IoT devices to monitor system on real time.
- Use AI for predict failure on basis of data analytics.

10) Performance monitoring & Continuous improvement =

- Track KPIs (Key performance indicators) like -
 - Availability of equipment.
 - Energy consumption.
 - Mean time between failures.
 - Mean time to repair.
 - Maintenance cost.
 - Waste generation.
- Conduct review & audits continuously.
- Using process like Lean mfg, TPM & Kaizen identify the problems & take effective actions.

Benefits of sustainable maintenance =

1) Reduction in impact on environment =

- Reduction in hazardous waste generation, pollution & greenhouse gas emissions.
- Eco-friendly maintenance practices are promoted.

2) Improvement in energy consumption =

- Machine/equipments work efficiently by adopting

sustainable maintenance cause reduction in energy utilisation.

3) Long life of m/c/equipment

Continuous maintenance prevents excessive wear & tear, increased the life of m/c/equipment.

4) Minimizes maintenance cost

By adopting sustainable maintenance, unexpected failure of machine reduces, Eliminates the major repair or replacement work.

5) Minimizes downtime.

6) Effective use of resources.

7) Improvement in safety

8) Increased productivity.

9) Low carbon footprint

10) Support to sustainable development.

4.3) Data Analytics in predictive maintenance

Introduction

Data analytics in predictive maintenance is the process of collecting, processing, analyzing data from sensors to predict future failures & determines the optimum schedule for maintenance. It improves reliability, reduce downtime & minimizes down & maintenance cost.

Process of Data analytics in predictive maintenance

- 1) Collection of real time data from machines.
- 2) Sensors can be use to monitor & collection of data.
- 3) Applies methods like statistical analysis, machine learning etc.
- 4) Detects abnormal operating condition by comparing real time data with historical data.
- 5) Predict future failure of machine before actual happens.

- 6) Provide baseline for decision making regarding maintenance schedule.
- 7) Improves efficiency & reliability in operations.

Concept of Computerized Maintenance management system (CMMS) =

CMMS is based on software that help in organizations plan, schedule, execute, monitor & record keeping of maintenance activities for machines/equipments and improves reliability, reduce downtime & optimizes maintenance cost.

It has centralized database provided ^{for} management of maintenance related information like m/c details, maintenance history, maintenance schedule, & workforce management.

Objectives of CMMS =

- 1) To manage maintenance schedule efficiently.
- 2) To schedule preventive maintenance.
- 3) To reduce downtime & unwanted breakdowns.
- 4) To improve reliability on process.
- 5) To maintain records of maintenance for future use.
- 6) To manage inventory of spare parts properly.
- 7) To improve productivity.
- 8) To reduce cost for maintenance.
- 9) To provide data for taking proper decisions.

Elements of CMMS =

- 1) Asset management = Data like detailed information of machine/equipment, specifications, location, warranty, maintenance history etc maintained properly in digital form.

- 2) Work order management = It manages the maintenance work by creating, assigning, continuous tracking and completion of maintenance task.
- 3) Schedule preventive maintenance = It automatically schedules maintenance based upon real time data from machines & historical data analysis.
- 4) Records of historical maintenance = It maintains historical data of inspection, repairs, replacement & servicing.
- 5) Inventory management = Help to maintain optimum level of spare parts, tools, lubricant, & consumables.
- 6) Resources management = Assign tasks, analyze performance and workload of employees.
- 7) Reporting & analytics = It analyzes the data to provide insights into maintenance activities, cost & machine performance using KPIs, & dashboards.
- 8) Document management = Keeps physical & digital records of user manuals, SOPs, drawings, & maintenance instructions.
- 9) Alerts & Notifications = Set reminders for schedule maintenance & notify it to operators.
- 10) Mobile app support = Some CMMS provides mobile apps to access information, monitor work flow & completion of tasks on time.
- 11) Integration capability = Integrate with IoT devices, barcodes, ERP, & other software like software for predictive maintenance.

Working of CMMS =

- 1) Asset registration
- 2) Maintenance planning
- 3) Automatic work order generation.

- 4) Work order assignment.
- 5) Maintenance execution
- 6) Data recording
- 7) Inventory management.
- 8) Performance monitoring.
- 9) Report generation
- 10) Continuous improvement.

Benefits of CMMS =

- 1) Reduction in machine downtime.
- 2) Increased machine reliability.
- 3) Long machine life.
- 4) Enhancement in preventive maintenance.
- 5) Record keeping
- 6) Improvement in work order management.
- 7) Inventory management improvement.
- 8) Reduction in cost of maintenance.
- 9) Increment in productivity.
- 10) Effective resource use.
- 11) Enhancement in decision making
- 12) Improved safety.
- 13) Real time monitoring
- 14) Supports continuous improvement.

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